POWER

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To The College Grad.

We had a wise editorial in our issue of May 14, entitled "The Technical Graduate and the Power Plant." If you have not read it yet, do so. Its ideas are those of one of your own professors of engineering, whose opinion you should accept. The subject seemed so very important and timely that we were constrained to add these words emphasizing the advantages to the young mechanical engineering graduate in starting his career in the power plant.

Apparently you feel you must get into an engineering office at once and be ready to start designing some important work as soon as your ability is recognized. It is a serious mistake to try to begin in the designing end before first acquiring valuable operating experience while you are young and can afford to do so. After you have spent a few months or a year each as regulator, operator, water-tender, oiler, watch engineer, etc., you can bring far greater judgment to bear when you finally do get into the designing office and you will rise faster than the man whose only foundation is his school training.

The pay of the beginner in the power house is as good as, or even slightly better than, that of the beginner in the drafting room. The difference lies in the hours and the work. In the drafting room the hours are from 9 a.m. to 5 p.m. or at the outside 8:30 a.m. to 5:30 p.m. Here you may wear good clothes and white collars and revel in a sense of dignity that some think belongs to the handling of drawing instruments and being surrounded by imposing-looking blueprints, slide-rule, etc.

On the other hand, as a novice in the operating department you must perform long hours of manual work probably in less comfortable surroundings and certainly in less polite garb. You deal in such commonplace materials as cotton waste, oil and grease, even dust and dirt. Many times a day you must swallow your pride and perform some humble task at the none too polite order of a superior, but such work ultimately brings its compensation in the form of useful knowledge of operating problems and ability to judge the merits of new schemes from the practical operating viewpoint, lack of which has led many a man to commit follies which lived long to discredit his ability.

To the largest success, both practical and theoretical knowledge are necessary. Until you recognize this fact the practical engineer will have the advantage of you. Your theoretical knowledge he may get from books and at home. His practical knowledge you can never get that way.

Take it from the professor and the present sermonizer—when you doff the "cap and gown," don the "cap and overalls."

Rope Brakes, Construction and Design

By Julian C. Smallwood*

Description of several arrangements of rope brakes with directions for using them and for calculating the horsepower from the scale reading.

Also how to design a brake to absorb a given horsepower; the size of rope, number of turns, and whether to employ water cooling.

*Associate professor of experimental engineering, Syracuse University.

For some reason, the rope brake has not found as much favor as other forms of absorption dynamometer. In spite of this, however, it has certain advantages which, in some cases, make it preferable to the wooden-block prony brake. The principal one is that it may be easily made, a rope brake often being put together in a few minutes with only such materials as are at hand. Furthermore, it is inexpensive, light and portable, and will cover a larger range of load than the wooden-block prony brake, which fact makes it desirable when necessary to test an engine at various outputs. It gives a more uniform frictional resistance to be overcome by the engine and this in spite of lubrication being unnecessary.

More accurate measurements can therefore be made as the chattering due to lack of uniform resistance is avoided. In the usual forms it is not necessary to measure the unbalanced weight as is the case with the prony brake, and this makes for ease and accuracy. It is more readily applied to vertical shafts and one brake is adaptable to several sizes of flywheel.

The only disadvantages of the rope brake are such as may be avoided by proper design. There is a tendency for the rope to stretch in operation, and such stretching may decrease the frictional resistance of the brake and therefore the output of the engine. This difficulty, however, is avoided in two of the forms about to be described. Also, in some designs, it is necessary to take readings of two brake forces instead of one to determine the brake horsepower; but this inconvenience may also be avoided.

The simplest form of rope brake consists of a rope wrapped around a flywheel or pulley on the shaft the power of which is to be measured, as in Fig. 1. The ends of the rope are attached to some stationary apparatus through spring balances for measuring the pull which is created by previously tightening the rope. Because of the friction between the rope and the flywheel, the motion of the flywheel tends to make the left-hand end of the rope tighter and the right-hand end more slack. Hence, there will be a greater tension in the left-hand than in the right-hand end, and the difference between these tensions will be the net force overcome by the engine. To vary this force, it is necessary only to change the initial tightness of the rope.

This force applied at the rim of the wheel multiplied by the circumference and the number of revolutions per minute gives the number of foot-pounds developed per minute, and this divided by 33,000, the brake horsepower. Since the circumference is the diameter (or twice the radius) multiplied by 3.1416, the horsepower becomes

$$B.h.p. = \frac{2 \times radius \times 3.1416 \times force \times r.p.m}{33{,}000}$$

$$B.h.p. = 0.00019 \times radius \times r.p.m. \times force$$

That is, to find the brake horsepower: *Multiply the radius of the brake in feet by the revolutions per minute and by* 0.00019. *Multiply the number so found by the net force in pounds indicated by the scale or scales and the product will be the brake horsepower.*

Strictly speaking, the radius of the brake should be taken as the radius of the wheel plus the radius of the rope, but, in most cases, the radius of the wheel only is sufficiently accurate.

It is seen that since only the difference between the rope tensions is needed it is not necessary to measure them separately. Separate measurement, however, allows a form of brake which is easier to make, although it is not so convenient to use.

The form of brake shown in Fig. 1 may be applied to a vertical shaft, and the rope tensions are measured by the spring balances $S\,S$, the turnbuckle being provided to vary the tensions. This brake is suitable for small torques (that is, where the mechanical power divided by the revolutions per minute is small) and high rotative speeds such as yielded by an electric motor or a steam turbine. For large torques, at least one of the spring balances must be replaced by a measuring device having a larger capacity. Fig. 2 shows how this may be done when the plane of the pulley is horizontal. The force is transmitted through a wooden bellcrank to the pedestal which rests on the platform of a platform scales. The bellcrank should be hinged carefully to avoid friction at this point.

The force on the slacker side of the rope is generally small and therefore a spring balance is sufficient to measure it. The use of two spring balances, even with small torques, is objectionable as they are apt to allow bodily motion of the rope. This may result in chattering.

In Fig. 3 one of the balances and the turnbuckle are dispensed with by using dead weights on the rope extremity having the greater tension. The horsepower is varied by adding or removing these weights. This brake has the advantage that an increase of length of the rope does not affect the brake load since such an increase would be accompanied by a lowering of the weights only, the tensions remaining the same. The weights should be provided with a stop P, to prevent an accidentally excessive friction from raising or throwing them. The spring balance of Fig. 3 may be replaced by another but smaller set of dead weights. Then, when weight is added to one side, enough should also be added to the other to produce equilibrium. It is an awkward matter, however, to do this nicely as unavailable subdivisions of weights are at times required.

In POWER of September 19, 1911, page 442, the author described a rope brake similar to that shown in Fig. 3, except that a single heavy weight is used on the left side and a set of small weights on the right. The heavy weight rests on a platform scales so that the rope tension on this side is the difference between the platform-scale reading and the weight on the scales. The brake load is varied by changing the weights on the right side. This device has been found very satisfactory in that fine regulation may be secured with very uniform resistance. In this case the net force overcome at the rim of the flywheel is the heavy weight minus the sum of the scale reading and the small weights.

In some cases there is not room to hang weights from the flywheel, in which case a brake of the type shown in Fig. 4 is applicable. The heavier tension is measured by the platform scales, being transmitted from the rope end by a lever L, having equal arms. The fulcrum is preferably a triangular piece of steel in order to avoid friction, but may be a pin, as shown. The handwheel is used to make fine adjustments of the load by tightening the rope; the turnbuckle may be used for coarse adjustments.

In volume XVI of the *Transactions* of the American Society of Mechanical Engineers is described a rope brake with which the difference of tensions is measured directly; that is, only one scale reading is necessary. Fig. 5 is a modified form of this brake. The ends of the rope are attached to the cross pieces $C\,C$ of a wooden frame which rests on a platform scales. If a handwheel is not conveniently obtained, a nut will serve the purpose for adjusting the rope tensions. It is important that the stops

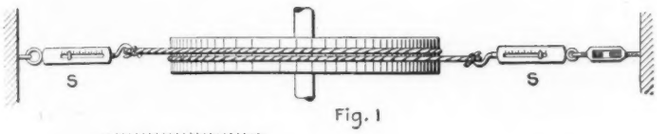


Fig. 1

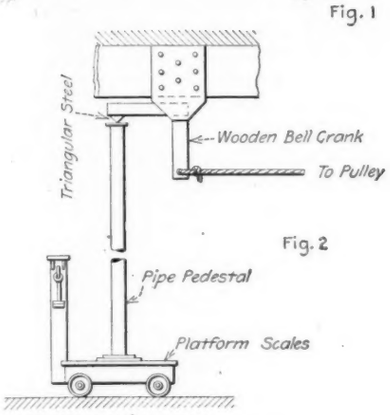


Fig. 2

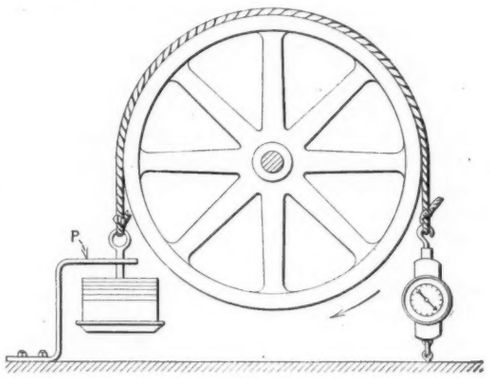


Fig. 3

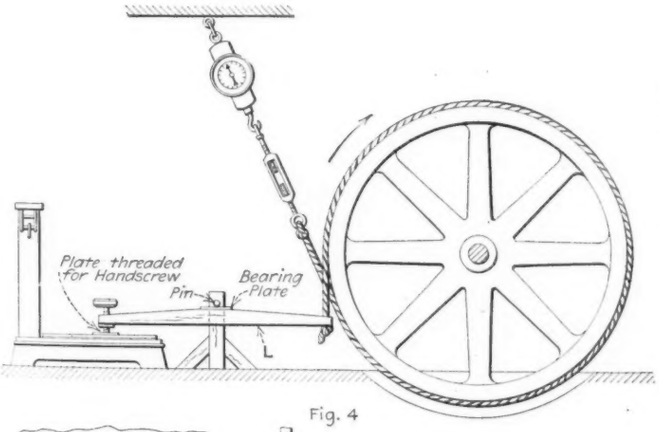


Fig. 4

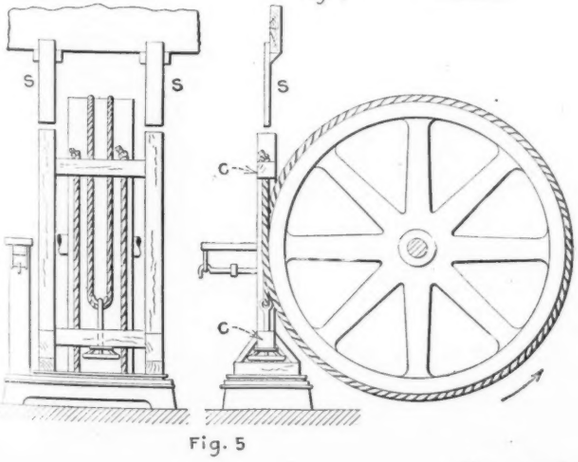
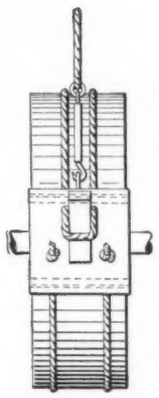


Fig. 5



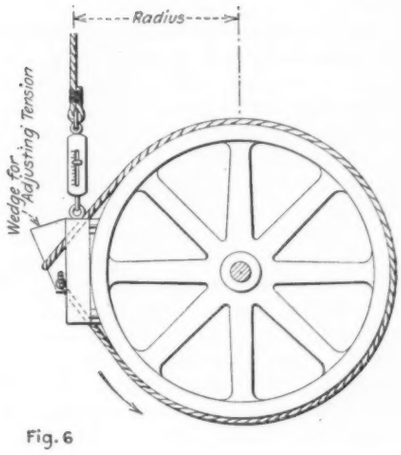


Fig. 6

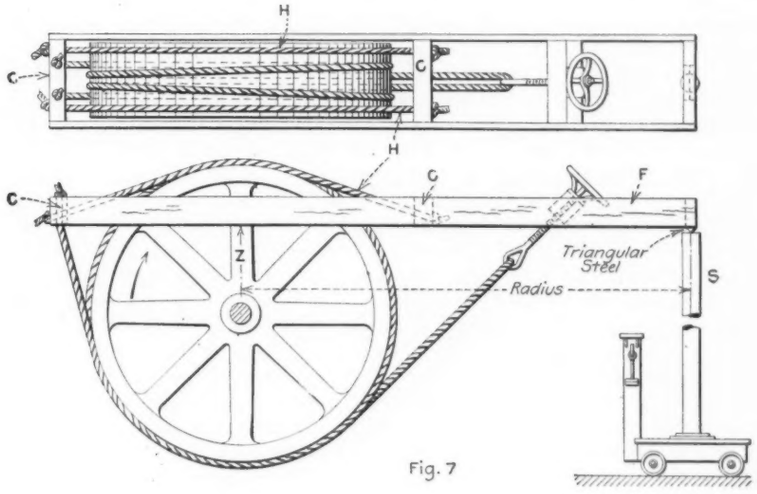


Fig. 7

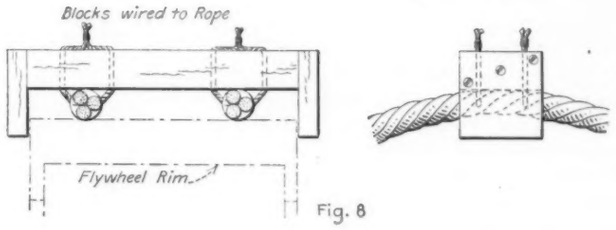


Fig. 8

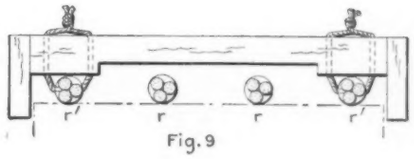


Fig. 9

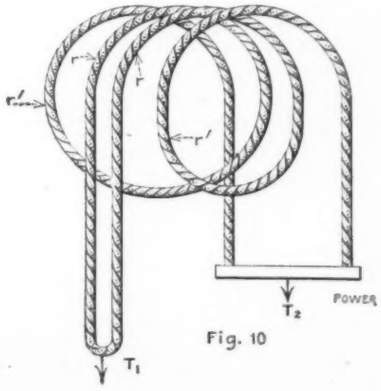


Fig. 10

VARIOUS TYPES OF ROPE BRAKES

S S be provided to prevent the lifting of the framework, if it is possible for the engine to reverse. The author has on several occasions used this type of rope brake and found it very satisfactory. It should be noted that the weight of the frame should be carefully determined with the ropes detached, and this weight subtracted from the readings taken during operation.

Fig. 6 shows another brake of this type, suitable for small torques and high rotative speeds. The wedge is used to adjust the tensions, and the net tension is measured by a single spring balance. The radius to be used in calculating the horsepower should be measured as shown. The weight of the block, wedge, etc., should be subtracted from the scale readings, if the brake is held by the balance from above, and added to them if below.

In Fig. 7 is shown a brake by which the thrust on the scales is kept low by the use of a brake arm *F*, the ends of the rope being fastened to the cross pieces *C C*. The arm is hung on the flywheel by the short ropes *H H*, and the thrust is measured by a platform scales through a strut *S*. The radius for use in the horsepower formula is as shown. This brake has the advantage of fitting various sizes of flywheel with a change only in the length of the rope.

The weight of this brake is not balanced; that is, some of it is recorded on the platform scales. This must be determined and subtracted from the gross readings of the scales in operation. To find the unbalanced weight, the brake may be removed from the flywheel, its strut end supported as in use and its flywheel end on a knife edge or small pin placed at the point *Z* which, when the brake is adjusted, is just over the center of the shaft. The rope should be entirely disengaged. With this arrangement the scales will indicate the unbalanced weight of the brake.

Water Cooling

Generally, if a brake load is to be carried by an engine for any length of time, some provision must be made to withdraw the heat generated by the friction to prevent the rope charring or catching fire. This is usually accomplished by feeding water into the trough formed by internal flanges on the rim of the flywheel or pulley to which the brake is attached. The water is flattened against the inside of the rim and retained there by centrifugal force. Usually, another pipe with a scoop-like entrance is arranged to withdraw the heated water. Very often, however, this is unnecessary, since, if boiling is allowed, the water supply may be adjusted so as to equal the evaporation; that is, evaporation disposes of the water without allowing the rope to get too hot. If the flywheel is not too small for the power absorbed, this means of disposal will be found effective.

Air radiation sometimes provides ample cooling when the brake pulley is large in comparison to the power absorbed. This is particularly the case when the brake load is to be applied for a short time only.

Some safeguard is needed generally to prevent the rope from slipping off the pulley. The rope, like a belt, tends to run to the center of a crowned pulley, and where only a single turn or half turn is used on such a pulley no other provision need be made to keep it on. For large powers, where a number of ropes are necessary, it is well to provide some other means to accomplish this purpose. An externally flanged pulley will do this simply; if one is not available, blocks like that shown in Fig. 8 may be fitted to the rope. This shows a block suitable to a single turn, or less, of double rope. Fig. 9 shows a block which may be used with a rope arrangement such as is represented diagrammatically by Fig. 10. This permits opposite motion of the ropes *r r* from that of *r' r'* when the whole rope stretches. Enough of these blocks should be fastened to the rope to hold it securely to the wheel.

Except for light powers, it is better to use double rope, as this provides more surface to resist wear without altering the desired relation of the tensions. Fig. 10 shows 1½ turns of double rope whereby the relative values of the tensions on the tighter and slacker sides are the same as would be obtained by a single rope wound in 1½ turns.

It is preferable to attach the device for adjusting the rope tension to that end upon which the tension is smaller, namely, the end which points in the direction of rotation. The preference is made because, the force being less, it requires less effort to change it.

If two spring balances are used the springs should be of different stiffnesses; otherwise their vibrations are likely to synchronize and a chattering will result.

The Design of Rope Brakes

The design is usually adapted to the size of pulley or flywheel at hand. It is first necessary to ascertain if the available pulley is large enough, if water cooling will be required, or if air cooling will suffice. For this information the following rule may be used:

Multiply the width of the wheel face in inches by the velocity of the wheel rim in feet per minute and divide by the horsepower to be absorbed. If the quotient exceeds 900, *air cooling will do. If it lies between* 400 *and* 900, *the brake should be water cooled. If it is less than* 400, *a larger wheel should be used.*

This rule is due to Flather (see Flather's "Dynamometers") and is intended to proportion the parts of wooden block prony brakes. The rubbing surfaces of this type of brake are much larger than those of the rope dynamometer; nevertheless, within the author's experience, the rule also applies to the latter type. This is probably due to the fact that the radiating surfaces in the two types are about the same. With the rope brake, the heat generated by the friction is quickly transferred from the limited contact surface to the adjacent parts of the rim, where it finds ample opportunity for radiation.

In order to determine the size and number of ropes to use, there must first be found the net force which the brake must handle; that is, the force which will be indicated upon the scale, or the difference of the forces if two scales are used. To find this:

Multiply the horsepower by 5250 *and divide the product by the radius of the wheel in feet and the number of revolutions per minute. The final quotient will be the net tension.*

It is well here to emphasize the meanings of the terms "net force" and "rope tensions." The net force is the effective force overcome by the engine. The rope tensions are the forces existing in the ends of the rope and their difference equals the net force. The tension in the tight end of the rope is therefore greater than the net force, and the rope must be strong enough to carry this tension.

The relative values of the rope tensions depend upon the number of turns around the wheel and the condition of the rubbing surfaces. Table 1 gives quantities that will reduce the calculations for design in the general case.

TABLE 1

Number of Turns of Rope	Ratio of Greater Tension to Net Force	Ratio of Greater to Lesser Tension
½	1.40	3.51
¾	1.18	6.59
1	1.09	12.3
1¼	1.05	23.2
1½	1.02	43.4

The data apply to well worn manila rope on smooth pulleys. This table gives the ratios of the brake forces for various numbers of rope turns. From it is seen, for instance, that with a one-half turn, the greater rope tension is 1.4 times the net force and 3.51 times the lesser tension. It follows that to find the greatest tension resisted by the rope:

Multiply the net force by the figure in the second column of Table 1, *corresponding to the number of turns in the first column.*

Using this result, a suitable rope to carry the load may be selected from Table 2. This gives the working strength of good manila rope of three strands. These values agree well with the data given by Flather, Reuleaux and the American Manufacturing Company, a factor of safety of about five being used. The rope is listed according to its largest diameter.

TABLE 2

Diameter, Inches	Working Strength, Pounds
½	300
⅝	450
¾	700
⅞	1000
1	1300
1⅛	1700
1¼	2100

Take, as an example, the design of a rope brake of the type shown in Fig. 5 for a 50-horsepower engine having a flywheel 5 feet in diameter and an 8-inch face, and running at 200 revolutions per minute. The velocity of the rim is then

$$3.1416 \times 5 \times 200 = 3141 \textit{ feet per minute}$$

Using the rule for cooling,

$$\frac{\textit{Width of face} \times \textit{velocity}}{\textit{Horsepower}} = \frac{8 \times 3141}{50} = 503$$

Since 503 lies between 400 and 900, water cooling is necessary. Using the rule for the net force,

$$\textit{Net force} = \frac{5250 \times \textit{horsepower}}{\textit{Radius} \times \textit{r.p.m.}} =$$

$$\frac{5250 \times 50}{2.5 \times 200} = 525 \textit{ pounds}$$

If one turn of rope is used, then, from Table 1 the ratio of the greater tension to the net force is 1.09. Therefore,

$$\textit{Greater rope tension} = 1.09 \times 525 = 572 \textit{ pounds}$$

From Table 2 it is seen that two ½-inch ropes would carry this load satisfactorily, since the working strength would be twice 300 pounds. But, to resist wear, it is better to use rope at least ⅝ inch in diameter except in the case of small powers. For this brake one ¾-inch rope would do, but two ⅝-inch ropes are selected for convenience in fastening the blocks.

For a brake of the type shown in Fig. 7, the calculation of the rope size is the same as that just given, but the thrust on the brake scales will be less than the difference between the rope tensions in the inverse proportion of the distances of these forces from the shaft center. For instance, if a brake arm of 7.5 feet were used with the brake in the preceding example, the thrust on the scales would be

$$525 \times \frac{2.5}{7.5} = 175 \textit{ pounds}$$

If the tensions are to be measured separately as in the type of the brake shown in Fig. 4, the capacity of the apparatus measuring the greater tension for the engine in the example must be at least 572 pounds. If a scales of this capacity is not available, the arms of the lever may be made of unequal length to reduce the force measured. The value of the lesser tension is found by dividing the greater tension by the ratio given in the third column of Table 1, thus,

$$\textit{Lesser tension} = \frac{572}{12.3} = 46.5 \textit{ pounds}$$

which determines the capacity of the spring balance shown in Fig. 4.

The third column of Table 1 is compiled from the well known belt formula which is also applicable to ropes; that is:

Ratio of tensions equals the number whose logarithm is 2.73 times the product of the coefficient of friction and the number of turns.

For the coefficient of friction, Unwin gives the value 0.28 for ropes on flat pulleys, and Flather uses a number somewhat higher. These figures, however, apply to the conditions of rope drive. Experiments made by the author to determine the coefficient of friction of well worn rope on a smooth pulley indicate that it is a quantity which varies markedly with the velocity between the rubbing surfaces and with the rope tensions. From these experiments it appears that an average value of the quantity is 0.4, and this value was assumed in compiling the table.

The second column of the table was found by the relation:

Ratio of greater tension to net force equals ratio of rope tensions divided by the ratio of rope tensions minus one.

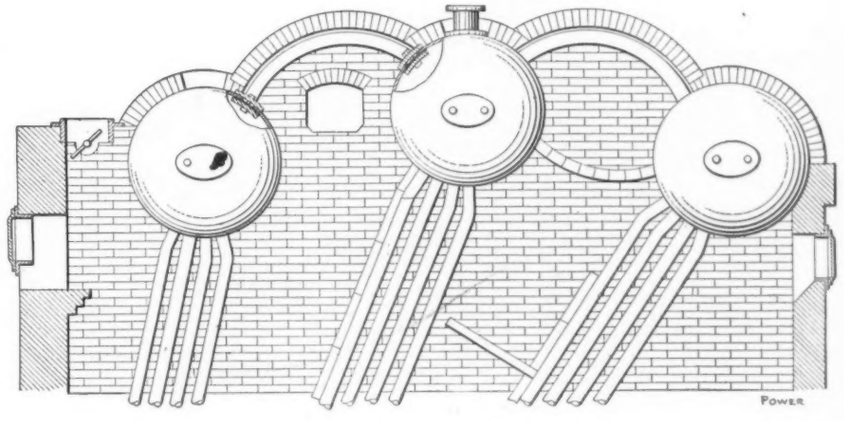
These formulas for finding the ratios of the brake forces will enable one to design a brake the conditions of which are not included in Table 1, as, for instance, would be the case if the wheel-rim surface were rough enough to make reasonable the assumption of a higher value of the coefficient of friction than 0.4.

In conclusion, it may be well to emphasize the fact that the rope brake, in general, is readily adaptable to given conditions. A selection from the types described may be governed entirely by the consideration of the materials at hand; or, if a superior product is wanted, the rope brake may be designed to be quite equal to, and often better, than other dynamometers in refinement, accuracy, convenience and cost.

It is pointed out by James Innes, in a paper, "Marine Boilers," read before the Institute of Marine Engineers, that there have been but few cases of late years where it has been necessary to repair the shell plating of boilers, although during the old compound-engine days it was common. This is because, in almost all cases, the shell plates have been made of steel of large size, and have been riveted by hydraulic pressure. Not only have the shell joints—the longitudinal and circumferential seams—been properly designed, but the former have been properly placed well up on the boiler side. In the eighties it was no uncommon thing to find longitudinal seams at the bottom center line, and in not a few instances has it been necessary to fit new butt straps or rerivet the old straps owing to leakage.

Emergency Boiler Repair

In a certain boiler plant it was found necessary to remove one of the equalizing pipes running from the rear to the center drum. After the equalizing pipe had been removed and the workmen were ready to put in a new one it was discovered that those on hand were too small in diameter to fit the hole in the steam drum. The engineer therefore decided to plug the holes.



How the Holes in the Drums Were Covered

Two blank pieces of cast iron were obtained which were an inch larger in diameter than the hole in the drum. A shingle was cut so that one end was of the same curvature as the inside of the steam drum. This was used as a pattern for the second gage. The inside plate was ground and filed until the second gage made a perfect fit with the outside surface of the blank piece.

The outside blank flange was fitted to the outside diameter of the drum in the same way, a bolt hole was drilled through both pieces, and after a solid-rubber gasket had been put on the inner blank flange a nut was placed on the threaded end of the bolt and the whole tightened up. Both holes in the drums were treated in the same manner, after which the boiler was operated until a proper size of equalizing pipe was obtained.

Operating Records of a Small Plant

By O. Monnett

Some actual figures from a plant serving a group of buildings with light, heat, power, hot water, etc.

During the heating season the cost of current amounts simply to the fixed charges against the electrical apparatus as all of the exhaust steam is used for heating.

The furnishing of light, heat and power from a central plant to a group of buildings involves a number of factors, all of which must be considered before a comprehensive plan can be worked out. When these buildings, as in the case of the Moody Bible Institute of Chicago, represent a number of different, though closely allied interests, so that the record of the service rendered to each by the power plant must be kept separately, each bearing its proportionate share of the expense, the book-keeping problem involved necessitates an accurate account of operating costs and a clear knowledge of all operating conditions.

The power plant, Figs. 1 and 2, of the institute is located in the basement of what is known as the old building, which, as shown in Fig. 3, is about the center of the property; there are walks and alleys on all sides of the building so that the engine and boiler rooms receive plenty of light and air.

Equipment

The main pieces of equipment are three 72-in. by 18-ft., horizontal, return-tubular boilers, with Burke furnaces; one 75-kw. and one 150-kw. Westinghouse generator, direct-connected to Ball engines. These are both three-wire machines and are provided with balance coils. There are also located in the engine room two boiler-feed pumps, two vacuum pumps, a large house pump, a feed-water heater and a hot-water service heater.

Two electric passenger elevators, an ice machine and various ventilating fans throughout the building furnish the power load, and to keep the cost data as accurately as possible the plant was equipped with the necessary measuring devices to check the daily operation in all of the various departments.

Besides a hot-water meter in the feed-water line, the boilers are fitted with a CO_2 recorder, so arranged that a reading can be taken from any boiler at any time, a direct-reading pyrometer and a differential draft gage.

A wagon scale is installed in the alley and all coal received is weighed. The engineer's gage board is provided with a recording steam gage and an integrating wattmeter on the switchboard checks the electrical output.

Heating Arrangement

The first problem was to take care of the heating of the eight buildings, new and old, from one central heating plant, and at the same time provide some means of measuring the amount of steam used in each building so that a charge could be made. The two new buildings, located as shown in Fig. 1, have Webster vacuum-heating systems, and one of the old buildings was changed over from a gravity-return to the vacuum system. Three of the old buildings, equipped with ordinary gravity systems, were disconnected from their old independent boilers and connected to the new system. The equipment in the Moody Church consists of a blast coil system and fan designed for steam at 50 lb. pressure. This was connected to the central plant by means of special supply line, carrying steam at 60 lb. pressure.

Meters

In each of the buildings comprising the group a dip meter was installed to measure the condensation from the radiators. It was found that the hot return water working under a vacuum was accompanied by a large amount of vapor which was not accounted for by the meters. To make these meters read correctly an ordinary double-pipe condenser coil was connected into the return line between the heating system and the meter to sufficiently cool the return water to prevent vaporization.

Traps were placed between the heating returns and the dip meters on the gravity systems, and by this means it was possible to condense the steam. Readings of these meters are made on the first of each month by the operating engineer.

Each of the buildings is also provided with a house-type wattmeter on the electrical-supply feeders and they are read on the first of each month. From these readings the various departments are charged for the light and heat used.

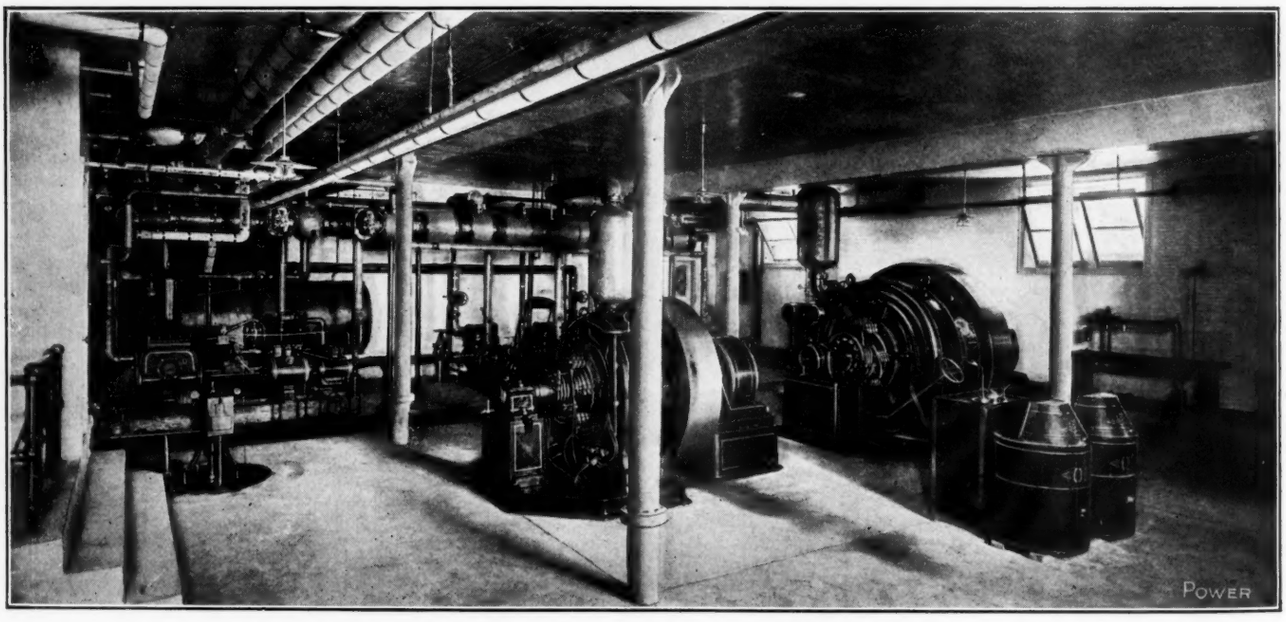


Fig. 1. Engine Room of the Moody Bible Institute, Chicago

As a check on the heating system and to be able to account for the total water used in the plant, the feed water is measured by a hot-water meter at the boilers. During the winter months, when there is no steam going to the atmosphere, the difference between the total reading of the dip meters and the boiler feed-water meter is charged to the heating of hot water for the buildings, the feed-water heater, vacuum cleaner and to steam used in the kitchen for cooling and dish-washing. This amounts to about 30 per cent. of the total steam used for all purposes during the winter months.

TABLE 2. MONTHLY STATEMENT OF HEATING, LIGHTING AND POWER

Date March 1, 1911

Labor		
Chief engineer	$110.00	
First engineer	85.00	
Second engineer	75.00	
First fireman	68.00	
Second fireman	30.00	
Third fireman	30.00	
General helper		$398.00
Supplies	Lb.	
Coal, on hand	110,000	$168.85
Coal bought during month	664,200	1019.55
Total	774,200	1188.40
Coal on hand	120,000	184.20
Net	654,200	1004.20
Lubricants		0.95
Boiler compound		
Packing		
Waste		
Miscellaneous		0.25
		$1005.40
General expenses		
Fixed charges, 1 per cent. per annum on $22,350	$223.50	
Repairs	30.50	
Hauling ashes	78.00	
Miscellaneous		$332.00
Total		$1735.40
Boiler Plant		
Total run during month		672 hr.
Total water evaporated in boilers		3,869,190 lb.
Total coal consumed		654,100 lb.
Total ashes removed		
Percentage of ashes removed to coal consumed		
Pounds of water evaporated per pound of coal consumed		5.9 lb.
Average horsepower in boilers		169
Cost of coal evaporating 1000 pounds of water		
Cost of producing 1000 pounds of steam		
Engine and Generator Plant		
Total run during month		672 hr.
Electrical output in kilowatt-hours		15,600 kw.-hr.
Average rate of current consumption in all buildings		23 kw.
Consumption of steam per kw.-hr.		
Cost per kw.-hr.		

Water-meter Reading

	Present	Last	Net
Men's building, 153, city water			64,486 cu.ft.

Steam-meter Readings

	Present	Last	Net
Men's building, 152, returns			370,000 lb.
Men's building, 153, returns			725,000 lb.
Women's building, 812, returns			100,500 lb.
Women's building, 830, returns			480,000 lb.
B.I.C.A. building, 826, returns			106,000 lb.
Church and Y. P. building, returns			157,000 lb.
Total			1,938,500 lb.

Electric Meter Readings

	Present	Last	Net
Men's building, 152, ammeter			2,435 kw.-hr.
Men's building, 153, ammeter			4,930 kw.-hr.
Women's building, 830, ammeter			4,149 kw.-hr.
B.I.C.A. building, 826, ammeter			298 kw.-hr.
Church and Y.P. building, ammeter			1,622 kw.-hr.
Elevator, men's building, ammeter			kw.-hr.
Elevator, women's building, ammeter			kw.-hr.
Kitchen, ammeter			94 kw.-hr.
Street lights and boiler room			1,400 kw.-hr.
Total			14,928 kw.-hr.
Vacuum cleaner run			196 hr.

Signed ..... Engineer.

Under the foregoing conditions, with the steam heating approximately 70 per cent. of the total boiler load, the electricity generated is considered practically as a byproduct. Even in the summer months, live steam is required for the vacuum cleaner, kitchens, laundry, etc., in the main buildings and the ventilating-fan engine in the church, while the exhaust from the electrical units heats the feed water and the hot water for the buildings.

Distribution of Costs

Table 1 gives a good idea of the general costs and power requirements, one month's record being taken for each of the four seasons of the year. The coal consumption shown is the total cost used for all purposes, including firing up, banking, etc.; in quality it is equal to No. 4 or No. 5 Illinois screenings, which run rather high in ash.

Monthly statements are made by the engineer on the form shown in Fig. 4, the figures being for March, 1911. From these data it is possible to figure the cost of any item desired.

Two methods of arriving at the electrical cost may be used. If the total cost per month is $1735.40 and the output is 14,928 kilowatt-hours, then the cost per kilowatt-hour is 11.6c. This, of course, is unjust, as all of the heating, ventilating, cooking, elevator service, etc., should be considered. As a matter of fact, there would be just as many boilers in use, as much coal burned and supervision necessary if the electrical plant were not installed.

The proper method of figuring the unit electrical cost in this instance, therefore, is to charge the electrical output with the fixed charges on the investment in the apparatus necessary to generate the current. This amounts to 12 per cent. per annum on $10,000, or $100 per month, making the cost 0.66c. per kilowatt-hour for the month of March, 1911, with the engines used as reducing valves on the heating system.

As a basis for arriving at the cost of

TABLE 1. OPERATING DATA OF MOODY BIBLE INSTITUTE

	Costs					Lb. Water Evap.	Lb. Coal Burned	Kw.-hr. Generated
	Labor	Coal	Supplies	Miscellaneous	Total			
Winter month	$370.50	$1067.75	$14.67	$44.00	$1496.92	4,170,720	695,100	14,220
Spring month	428.25	462.62	79.77	141.75	1112.39	2,032,000	450,000	6,510
Summer month	320.00	245.27	72.46	45.05	682.78	967,000	156,000	5,300
Fall month	360.06	396.25	35.08	42.87	834.26	1,599,000	262,000	9,055

FIG. 2. THE BOILER EQUIPMENT

1000 lb. of steam it is figured that if the charges against the electrical equipment amount to $100 per month, the total monthly cost minus $100 gives the cost of the steam generated. This, in the case of March, 1911, is $1635.40, and as 3,869,190 lb. of water were evaporated in the boilers for this month, the cost per 1000 lb. is 42.3c.

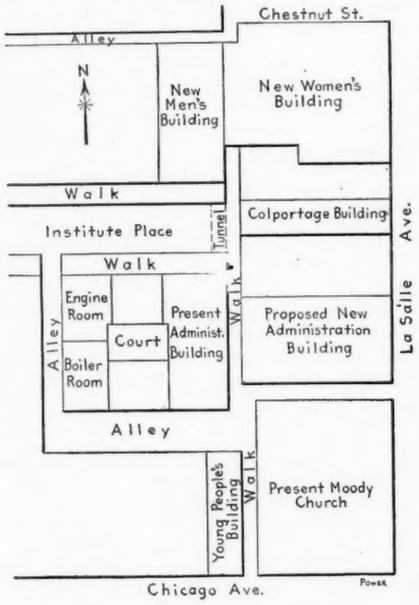


FIG. 3. PLAT OF BUILDINGS

A nominal charge is made against each building for the current used and a rate per 1000 gal. of condensation in the heating system is charged such as will enable the total cost of the power plant to be divided among the several buildings according to the service rendered; with the data available this becomes a simple matter.

W. A. Blonck & Co., consulting engineers of Chicago, designed and installed the plant.

Boiler Waters

On the evening of Apr. 30, W. A. Converse, chemical director of the Dearborn Drug & Chemical Works, of Chicago, Ill., lectured on boiler waters before the Modern Science Club at its quarters, 125 South Elliott Pl., Brooklyn, N. Y.

The lecture was illustrated by many stereopticon views of analysis charts, corroded tubes and scale formations; views of the Dearborn Laboratories and of natural lime formations in Yellowstone National Park. The demonstrations given of methods of analyzing feed waters were very thorough as the apparatus and paraphernalia used by Mr. Converse were equal to that found in many laboratories.

After dwelling on the constituents of water and briefly defining a few chemical terms, the speaker said that the carbonates of lime were supposed by many engineers to cause only a scale formation in the boiler. He contended that serious cases of foaming were sometimes due to their presence in the water. The dissolving effect of alkaline substances in boiler water on the gaskets and packing used on the boilers was well brought out. Mr. Converse stated that Eastern engineers are favored with extraordinarily good feed water as compared with Western districts. He illustrated by analysis charts some Western waters which showed that they contain very little carbonates of lime, while they are high in sulphates of lime and therefore dangerous on account of the rapid formation of exceedingly hard scale.

A case was cited where there were 27 lb. of lime substance deposited every 24 hours in a boiler located in a Western state. The deleterious action of sulphuric acid when present in feed water was explained as due to its concentration. With feed water high in sulphuric acid, the water is evaporated while the acid remains in the boiler. As the volume of water evaporated becomes greater, the amount of acid also increases to a point where corrosion is very rapid, owing to the affinity of sulphuric acid for iron.

Analysis cards of other Western waters showed a high percentage of sodium and potassium sulphates, the action of which is severe on boiler plates. These substances are not precipitated and are therefore difficult to deal with; the only cure for such water is to distill it before its use. The corrosive action of magnesia salts, said Mr. Converse, is due to the salts being affected by high steam pressures and thereby giving off muriatic-acid fumes which not only affect the boiler plates but are injurious to the steam piping and engine cylinders as the acid is carried by the steam used in them. The causes of foaming and priming were also clearly explained.

The speaker cautioned against unwise legislation governing the use of feed waters, stating that in many Western districts it was possible to obtain only one grade of water, and that often this water was highly deleterious for boiler purposes, but as better water was not available it was a case of tolerating an unavoidable evil.

Analysis cards of waters taken from the East and Middle West districts were then explained. A recent analysis of Croton water showed that it contained hard scale-forming agents, but could be considered a fairly good water. Brooklyn city water was also said to be fair. The water from Clifton, Staten Island, the speaker said, was low in carbonates of lime, but as a water containing corrosive agents it was one of the worst he had met with in 20 years' experience in analyzing and treating boiler waters. The action of this water is to pit and corrode, forming very deep grooves above the water line and a hard scale below the water line.

The water of South River, N. J., was considered remarkable, inasmuch as it contained an exceedingly high percentage of sulphuric acid, while there was no apparent reason for its presence in the water. The sulphates were also high; consequently it was a vicious water for boiler purposes. Monongahela River water at Pittsburg also proved high in sulphuric acid. The water at Atlantic City was shown to be high in silica. Satilla River water, taken from Waycross, Ga., contained dangerous corrosive agents; the galvanic action set up by this water was said to be one of its characteristic features.

To illustrate how river water varies in substances injurious to boilers, the speaker showed several analysis cards of Mississippi River water the samples of which were taken from points between Minneapolis and New Orleans. It was surprising how the percentage of impurities increased at each southerly point. The waters of the Great Lakes are also similar in their variation of impurities.

Views of lime formations were next shown; among them that of an internal feed pipe, on the end of which was an enbow. The lime had accumulated on the fitting until it appeared nearly three times its original size; the opening had been reduced to about one-fifth its original diameter.

The lecture was well attended, and Mr. Converse was highly successful in reducing the technical matter to ordinary and understandable terms.

Oil Burning Plant at Irish Shipyard

To be independent of coal as a fuel, four large boilers at Harland & Wolff's Shipbuilding Works on Queens Island, Belfast, Ireland, have been adapted for oil fuel. Using coal for fuel, one of these boilers evaporates 16,000 lb. of water an hour and the other three 12,000 lb. each, and with liquid fuel they will generate 4000 hp. per hour. The work of installation is so simple that it can be carried on without letting the steam out of the boilers.

The steam-jet system is used. The oil enters the boiler through a branch pipe and is given a whirling motion by the prolonged spiral stem of the valve spindle, the amount of oil being governed by a handwheel at the end of the spindle. The steam enters at another valve and passes through slots in the cylindrical part of the cone. All the oil passing through the burner is thus steam jacketed. One or two men can attend to a dozen boilers burning liquid fuel.

Notes on Steam Boiler Efficiency*

By Edward A. Uehling

Boilers under test conditions compared with those under ordinary working conditions. The relation of draft and the percentage of CO_2 to efficiency.

*From a paper read before the Master Mechanics Association of America, at Boston, on Apr. 26.

Fifty years ago a steam engine that consumed less than 40 lb. of steam per horsepower-hour was quite the exception. Twenty-five years ago 30 lb. was accepted as good practice. Today a steam consumption above 20 lb. is considered unsatisfactory, and in exceptional cases a steam consumption as low as 10 lb. per horsepower-hour has been reached.

The best average boiler efficiency fifty years ago was probably close on to 60 per cent; 25 years ago it was about 60 per cent., and today the average boiler efficiency still hangs close to 60 per cent. Thus while the steam engine has been so improved that a given amount of steam will produce nearly three times the power obtainable 50 years ago, the steam boiler continues to waste 40 per cent. of the heat energy contained in the fuel. There are several reasons why this is so:

To begin with, the steam boiler (including its setting) because of the simplicity of its function, had been developed into a far more perfect apparatus for the purpose of generating steam 50 years ago than was the steam engine of that time. Later, however, thorough investigations of the properties of steam were carried on by scientists, who formulated the laws of expansion, thereby not only revealing the great wastefulness of the then existing steam engine, but at the same time pointing out the upper limits possible to attain. Based on these revelations of science, inventive genius and mechanical skill, in combination with practical experience, wrought the great improvements embodied in the many types of engines of today, including the steam turbine.

The principal reason for the slow progress in the economical operation of the steam boiler is due largely to the fact that it is of necessity a rough and uncouth apparatus, placed in dirty, dingy surroundings, generally indifferent and often inadequately housed.

Brawn and muscle are considered the principal requirements in a boiler attendant. As a rule, neither compensation nor environment is calculated to attract the more intelligent from among the men available, and perhaps there is not one fireman in a thousand who has any conception of the chemical reactions that constitute the process of combustion.

The steam engine, on the other hand, is a highly finished machine, housed in well lighted and well appointed quarters, therefore commanding and receiving close attention. Furthermore, it is attended by high-class men, trained by education and long experience, who understand its mechanism and mode of operation.

Again, in the steam engine, although it is a complex mechanism as compared with the steam boiler, the regulations and adjustments necessary to maintain maximum efficiency are exceedingly simple in comparison to what is required to attain and maintain the highest boiler efficiency.

A steam engine correctly designed and properly constructed, accurately adjusted and adapted to the work to be performed, will give maximum economy. The speed is uniform and the steam used is automatically regulated to suit the load. Certain definitely fixed and automatic adjustments have been found to give maximum efficiency; the attendant has only to maintain these adjustments to insure efficiency.

The efficiency of the steam generator depends on far more complex conditions, many of which are not only beyond control, but are continually changing. Some of them are atmospheric conditions, quality of the fuel and the condition of the boiler as to setting, dirty heating surface, air infiltration, draft, etc. The grates become choked with slate and clinker, obstructing the air passages and causing irregular flow, resulting in a deficiency of air in one place and an excess in another. Every one of these variables affects the efficiency of the boiler furnace. Furthermore, the required output, which varies in some plants between very wide limits, is an important factor. One is therefore forced to the conclusion that the lack of progress in boiler efficiency under actual operating conditions is not due to any want of improvements in design and construction of the present-day boiler and setting, though much remains to be desired, but that it is due almost entirely to insufficient knowledge of the conditions involved and consequent wasteful manipulation.

That this is true is proved by the fact that almost invariably official boiler tests, made by or under the direct supervision of experts, show from 10 to 20 per cent. greater efficiency than is obtained from the same boilers in everyday practice. This raises the question, can the high efficiency obtained by an expert be at least approximately maintained in everyday practice? If so, how can it be accomplished? What does the expert do to get his results?

He analyzes the coal for the purpose of ascertaining its heat value, and to find out how to burn it effectively. He brings with him one or more expert firemen, or selects the best available from the existing staff, and generally pays them extra to insure good work. He makes sure that the boiler is clean, inside and out, that the grate bars are whole and straight and suitable for the kind of coal to be burned. He sees to it that there are no cracks and crevices in the boiler wells and that the cleaning doors closed tight.

He is also assisted by a staff of trained observers. One keeps a careful record of the weight of coal fired; another accurately weighs or measures the feed water; a third analyzes the flue gas and notes its temperature, while the fourth ascertains the quality of the steam. Many other data are noted and recorded, all of which are necessary to enable the expert to calculate the efficiency of the boiler under test and to strike a heat balance. But with the exception of those appertaining to the composition and temperature of the flue gas, none of the data noted and recorded by the staff of assistants is of the least aid in attaining high efficiency. And since the two essential elements in the flue-gas records, CO_2 and temperature, can be autographically recorded and continuously indicated by appliances readily available at reasonable cost, an expert and a corps of assistants are not required to assure economic boiler operation in everyday practice.

Sifting the essentials from the non-essentials in the progam of the expert boiler testing, there are:

(1) Clean boilers; (2) tight settings; (3) skillful firing; (4) knowledge of the chemical composition and physical properties of the coal used; (5) furnace adapted to the fuel; (6) draft regulation; (7) continuous knowledge of the percentage of CO_2 contained in the flue gas, also its temperature at the point where it leaves the boiler.

The first five of these conditions essential to boiler efficiency should be quite self-evident.

1. As to clean boilers, it should not require the services of an expert to keep the boilers clean, yet a great deal of coal is wasted because of dirty and scaly heating surfaces.

2. Tight boiler settings are the exception rather than the rule. Should an expert and a staff of assistants be required to keep the settings tight? Certainly not. It is nevertheless a deplorable fact that air infiltration is one of the

most prolific causes of low boiler efficiency.

3. Every material change in the chemical and physical property of the coal requires a change in the method of firing, the frequency of cleaning the fire, the strength of draft, etc.; a correct knowledge of the chemical composition and physical poperties of coal used will, therefore, be of material assistance in maintaining high efficiency in everyday practice.

4. Regarding the furnace and grate bars, every steam engineer of experience knows that they must be adapted to the kind of coal available if good results are to be realized. It may and generally does require the service of a combustion expert to determine the grate and furnace construction best adapted to burning a given fuel; but when these conditions are once established there is no good reason why they should not be maintained.

5. Draft regulation is one of the most important factors and is probably the least understood. Draft, whether natural, forced or induced, is manifested by a difference in pressure. The effective draft is the difference in pressure between the air under the grate bars and that at the point of leaving the boiler. It may be considered as divided into two parts, namely, the furnace draft and the boiler draft. The former is the pressure difference between the ashpit and the furnace, and the latter is the pressure difference between the furnace and the uptake. The boiler draft varies directly with the volume of gas coming from the furnace; hence for the same rate of combustion it varies inversely as the percentage of CO_2 in the flue gas, and for the same percentage of CO_2 it varies directly as the rate of combustion.

The furnace draft depends on many things: the kind of coal, the rate of driving, the thickness of the fire, and its condition, the formation of clinker, etc., from all of which it is evident that the proper regulation of the draft requires close and intelligent observation and judgment.

6. Skillful firing and intelligent manipulation are therefore prime requisites in the economic operation of steam boilers, and that is why the expert, when he is conducting an efficiency test, is so particular in selecting his firemen. To overcome any errors in judgment on the part of the firemen, he resorts to analyzing the flue gases, which is the only correct and adequate method of controlling the process of combustion.

Maximum efficiency results when the necessary amount of fuel is completely burned with a minimum excess of air, and the flue gases leave the boiler with the lowest temperature consistent with the rate of driving. Without adequate means of knowing when this condition obtains, it is impossible for even the most expert fireman to maintain maximum efficiency.

Combustion experts when conducting efficiency tests generally determine the percentage of CO_2, CO and O; but for everyday practice it is necessary only to know the percentage of CO_2 and the temperature of the flue gas to be able to tell whether the boiler is being operated economically or wastefully, and to what extent heat is going to waste up the chimney.

Not less than 90 per cent. of the avoidable heat losses in the operation of steam boilers are due to excessive air supply, and since the percentage of CO_2 in the flue gas is a correct index of the excess of air it contains, an instrument that will continuously indicate and record this constituent is a most important if not an absolutely necessary factor in attaining and maintaining maximum boiler efficiency.

A continuous record of the temperature of the escaping flue gas, although less valuable for controlling the boiler operation, is nevertheless of great importance. The temperature when recorded simultaneously with the CO_2 will give most valuable information as to the condition and operation of a boiler. The temperature of the flue gases is but slightly affected by excess of air supplied to the furnace; hence cannot be directly controlled by the fireman. This depends on the ratio of the heating surface of the boiler to the grate area, on the condition of the heating surface, and on the rate of driving; also, the stack temperature is markedly affected by air infiltration, while an excess of air supplied to the furnace affects the stack temperature but slightly.

Thus it is seen that while the stack temperature alone may give very misleading information, in conjunction with a determination of the CO_2 very valuable information is had about the condition of the boiler itself as well as the boiler setting.

A draft gage applied to the furnace shows the resistance through the ashpit door, the grates, the ashbed and the fire. With a given effective draft, if the ashpit doors are partially closed the furnace draft is increased, but the rate of combustion is decreased. The same effect is produced by the accumulation of ashes, the formation of clinker and the caking of the coal. The furnace draft is thus increased by at least four distinct causes, all of which tend to check the rate of combustion. On the other hand, if the fire is sliced, the furnace draft is decreased and combustion is increased, and still more is this the case if the fire is cleaned. It is clear then that the readings of a draft gage in the furnace cannot be relied upon as an index to the rate of driving, much less to economical operation.

From the foregoing it would appear, first, that the chimney draft is affected favorably by wasteful boiler operation, due to high stack temperature, and unfavorably by wasteful operation, due to a low percentage of CO_2 in the flue gas; but that a knowledge of the chimney draft and temperature is of great value as a check on economic operation of a boiler plant; second, that the effective draft upon which depends the rate of combustion is itself dependent on the variable conditions of the furnace, that it cannot be relied on as a guide by which to regulate combustion; third, that furnace draft due to the ever changing conditions, must necessarily vary if a definite rate of combustion is to be maintained, and is, therefore, useless as a guide, but is of the greatest value as an index to the condition of the furnace, provided there is a true index to the rate of combustion. Fortunately, such an index can be made available.

From what has been said in the foregoing, it should appear evident that in order to attain and maintain high boiler efficiency it is necessary to employ scientific means for the purpose of gaining the information necessary to economical operation.

Damper and Fan Control

The method of controlling the damper and engine-driven forced-draft fan at the new power plant of the Hazard Manufacturing Co., Wilkes-Barre, Penn., is interesting and out of the ordinary.

The gases of combustion pass from the boiler to a rear connection, which is built at the back end of the boiler setting and is separated from the smoke flue built in the basement by a damper, which covers an opening 2 ft. 6 in. wide and extends the width of the boiler setting. Each boiler is equipped with this type of damper, so that any one boiler or all can be cut out from the smoke-stack connection.

Damper Arrangement

This damper is hinged on the inner edge and is provided with an eye-bolt, to which a chain is attached. The other end of the chain is connected to an adjustable rod that connects at the upper end with an arm which is secured to a shaft. This shaft is carried by hangers attached to the back wall of the boiler room and extends over the boiler settings. The general arrangement of the damper regulator, shaft connections and damper arrangement is shown in the accompanying illustration. The flat rod to which the chain from the damper is connected is made with suitable holes for adjustment, so that the damper can be regulated as to the amount of opening. As a means of counter-balancing the weight of each damper, pulleys which hang in a bracket attached to the brick wall

of the engine room serve as guides for weight cords, the several weights acting as a counter-balance to the several dampers.

The shaft in the boiler room is arranged with clutches, so that the arm to which the damper rod is connected can be disengaged from the shaft, and the other dampers operated independent of the cut-out damper. This permits of the damper being closed on any particular boiler when it is out of commission for repairs, etc.

The end of the damper shaft *D* is fitted with an arm, to which is connected another shaft *C* running at right angles to it, and which is in turn connected by a similar arm to a shaft *A*. This shaft is hung to the wall just above the damper regulator in the pump room, and is connected by means of an arm and rod to an auxiliary cylinder, the plunger of which is operated by means of the damper regulator, the connection being as shown.

An ingenious method of determining the amount any damper is open has been arranged in the center-shaft *C*, in that the shaft is made in two sections and is drilled and tapped with a right- and left-hand thread.

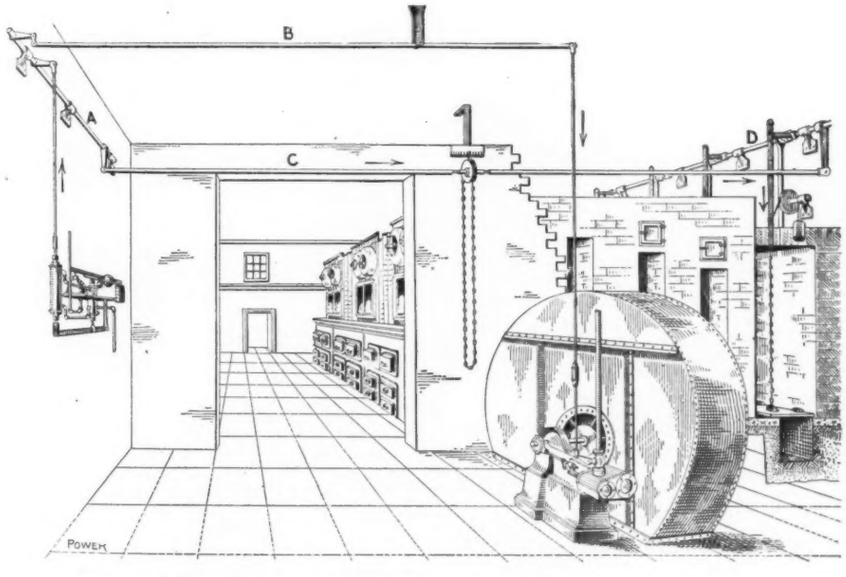
Damper Inidcator

The rod, which is threaded and screws into the two ends of the shafts, is fitted with a wheel over which a chain is run. There is also an index pointer which, as the wheel is revolved by means of the chain, is moved either to the right or the left, according to the way the screw connection is revolved. This indicates on the scale placed above the indicator pointer the amount the damper is open. Thus, the fireman is in a position to know the open position of the dampers.

Fan Regulaton

The speed of the fan engine is also regulated by means of the damper regulator. Attached to the end of the shaft *A*, mounted above the damper regulator, is an arm that is connected with a lever *B*, pivoted as shown. To the end of this lever a rod is connected to which a turnbuckle has been fitted and which connects with the lever attached to a butterfly valve in the steam pipe leading to the cylinder of the fan engine.

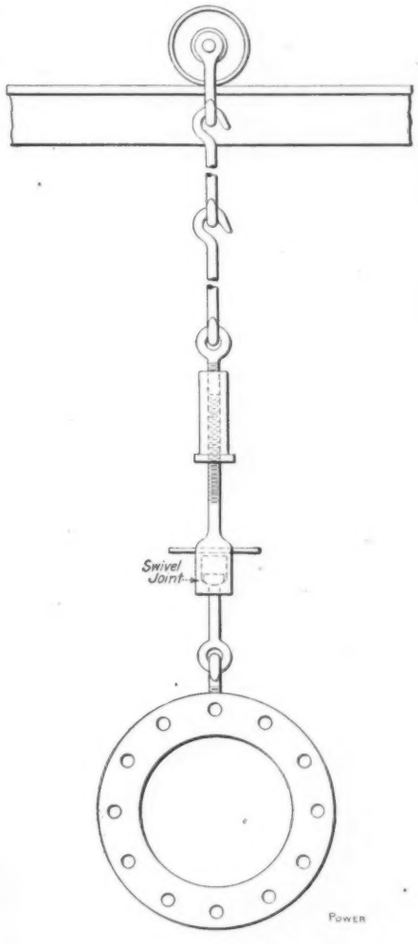
When the steam pressure rises, the damper regulator causes the piston in the auxiliary cylinder to rise and thus actuates the adjustable cross shaft in the direction of the arrow, and this motion is communicated to the several dampers that are attached to the arms extending from the damper shaft and closes them. At the same time the end arm is moved upward, which will cause the end connected with the rod attached to the steam valve to move downward, and this closes the steam valve in the fan engine's steam pipe. Thus the draft is decreased in the furnace. A reversal of this operation opens the furnace to the natural draft in the chimney and at the same time the fan is speeded up. The arrangement is automatic and allows of close regulation as the amount of damper opening in the boiler smoke flue can be regulated for increased draft as the furnace fires become dirty.



How the Regulator Controls the Damper and Fan Engine

Device for Removing Cylinder Heads

A device for removing the cylinder heads of hoisting engines is shown in the accompanying illustration. A T-rail is suspended by means of suitable hangers directly over the center of the cylinder. On this rail a pulley runs to which is fitted a yoke through which a pin passes, and upon which the pulley revolves. Secured to the lower side of the yoke is an iron rod which has a hook formed at one end and an eye at the other. A second similar rod is hooked to the first one, both of which are ¾ in. in diameter. To the eye of the second rod a turnbuckle arrangement is secured, which consists of a rod in which a threaded screw turns, the bottom end of the screw being drilled for a rod to turn the screw. The lower end of the screw is made with a swivel joint, as shown, and the lower end of the swivel is made with an eye. An auxiliary piece,



Cylinder Head Crane

with one end threaded, screws into a suitable hole in the cylinder head; the other end is made in the form of a U with a hole drilled through the open end so that a pin can be passed through it and the eye-screw.

As soon as the stud-bolt nuts have been removed, the swivel screw is tightened so that the weight of the cylinder is suspended by the arrangement when the whole is pushed back out of the way. This device is in use at the No. 2 colliery of the Susquehanna Coal Co., Nanticoke, Penn.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Catechism of Electricity

Care and Management of Arc Lamps

1263. *What are the principal features to watch out for, to insure the proper operation of arc lamps?*

Assuming that the lamps are substantially made, their proper operation depends chiefly upon their being properly trimmed and correctly adjusted for the voltage at which they are designed to work.

1264. *In trimming an arc lamp, what are the important points to be observed?*

The use of proper carbons; removal of dirt from the clutch rod before pushing the rod up; placing the carbons so that they are vertically in line with each other and have enough vertical play to allow the lamp to pick up its arc; care to see that the carbon rods are firmly screwed into their holders; inner globes thoroughly cleaned, and if nicked or cracked so as to allow leakage of air, to be replaced by new globes; proper adjustment of the moving parts.

1265. *How should the carbons for inclosed arc lamps be selected and replaced?*

The carbons used should be of the best quality so that the quantity of deposited matter due to combustion will be as small as possible; they should be free from blisters, or roughness, hard spots and curves. A good guide as to the quality of the carbon is the appearance of the burned ends. Good carbons after being used present a dull surface, whereas the ends of hard carbons present a glossy pitted surface.

The trimming of inclosed arc lamps outdoors is facilitated by the trimmer taking with him a clear inner globe fitted with a lower carbon, to replace the old one in each lamp. It is necessary that the carbons be of the proper length. The upper carbons can be purchased of the desired length, but as the lower ones are often made up of the part left over from the upper carbon they should be cut to the proper length before being used for this purpose.

The proper operation of an inclosed arc lamp depends largely upon the free passage of the upper carbon through the cap of the inner globe. A ½-in. carbon should not be smaller than 0.5 in., nor larger than 0.52 in.; if smaller than 0.5 in., too much air will be admitted and the arc will flame.

1266. *What is the method of adjusting an arc lamp for the proper voltage?*

Before an arc lamp is installed, it should be adjusted for its proper arc voltage, which is usually 70 to 75 volts measured across the inclosed arc. The lamp should be burned about ten minutes before this measurement is taken so as to allow the carbons to assume their normal operating condition. Directions for adjusting the different makes of arc lamps vary considerably, so that no specific rules can be given to fit all cases. Directions, however, can be obtained from the manufacturers and they should be closely followed to secure satisfactory results. When adjustments are made without the use of a voltmeter, it is well to bear in mind that if the arc hisses it is too short, and if it flames badly it is too long. By watching the fluctuations of a voltmeter across the arc, as the carbons burn, a good idea may be formed of the smoothness with which the mechanism feeds.

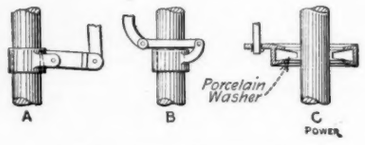


FIG. 417. CLUTCHES

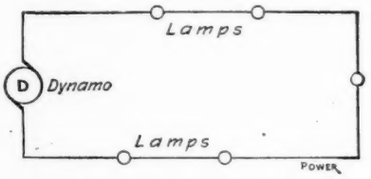


FIG. 418. ARC LAMPS IN SERIES

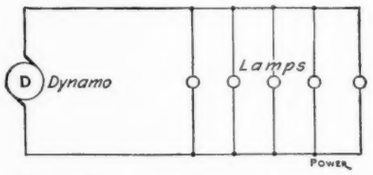


FIG. 419. ARC LAMPS IN PARALLEL

1267. *In case a lamp does not feed properly, where is the trouble usually found?*

In the dashpot or in the clutch, if the feed magnet is not burned out.

1268. *How may trouble in the dashpot be remedied?*

By wiping it clean with a dry cloth. If this does not clear the trouble, remove the dashpot and clean with gasoline the little check valve which has probably become stuck. Oil should never be used on it. If the valve is all right, the piston has probably worn loose, in which case a new one should be used.

Where arc lamps are used only occasionally, but must be kept ready for immediate use, the formation of scale inside the cylinder of the dashpot may be prevented by lighting the lamp for a minute or two every day. This daily action of the piston will scrape off the scale before it hardens sufficiently to interfere with the performance of the dashpot.

1269. *How may trouble in the clutch be remedied?*

In two-part metal clutches, such as shown at *A* and *B*, Fig. 417, dirt is liable to work in between the parts, which will then require cleaning. If, through the breaking of the upper carbon lead, the clutch is forced to carry the lamp current, it is liable to burn and bind the pivot pins. In all two-part metal clutches it is necessary to keep these pins loose to insure free operation. The porcelain washer clutch *C*, Fig. 417, is not subject to pin trouble, but may break if there is "jumping" of the carbons, in which case a new porcelain washer must be substituted.

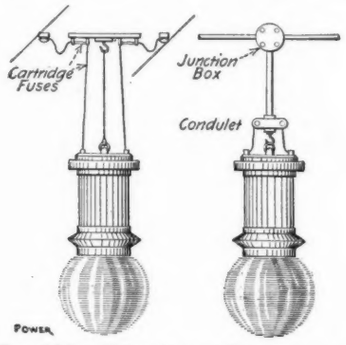


FIG. 420. METHODS OF SUSPENSION

Connection of Arc Lamps in Circuit

1270. *How are arc lamps usually connected for street lighting?*

In series, as indicated in Fig. 418.

1271. *What are the current and the voltage conditions in a series circuit?*

The current through all the lamps is the same, assuming there is no leakage, and this current must be kept constant to obtain a steady illumination. If each lamp requires 75 volts, and there are fifty lamps in circuit, the generator must develop

$$50 \times 75 = 3750 \text{ volts}$$

plus the drop in the line.

In case any of the lamps are cut out by short-circuiting them, this being the only way in which lamps on a series system can be cut out without opening the circuit, it is evident that if the voltage remains constant the current will increase and perhaps burn out the lamps remaining in circuit. To prevent an increase of current under these conditions, an automatic regulator is used in connection with the dynamo.

1272. *How many lamps can be operated in a series circuit?*

About 100 lamps is the maximum that is considered practicable on a single circuit. This requires an e.m.f. of approximately 7500 volts.

1273. *How are arc lamps usually connected for interior lighting?*

In parallel across a constant-potential circuit, as shown in Fig. 419.

1274. *What are the voltage conditions in the multiple circuit?*

As the usual interior constant-potential circuit is operated at about 110 volts and the voltage across the inclosed arc is about 75, there remains about 35 volts to be taken up by the resistor in the direct-current lamp, or by the reactance in an alternating-current lamp. In an open-arc lamp, however, the voltage across the arc is only about 45 to 50, so that about 60 to 65 volts is wasted in dead resistance.

1275. *Is this greater loss of voltage in the open-arc lamp responsible for this lamp being superseded by the inclosed-arc lamp for multiple connection?*

Not entirely, because it is possible to operate two open-arc lamps in series across a 110-volt circuit, leaving only about 20 volts to be lost. The inclosed-arc lamp won out chiefly by reason of the slower combustion of the carbons and consequent saving in operating and maintenance cost, the softer light it gives, the better distribution of this light by means of the inner globe, the impossibility of heated carbon particles flying out and setting fire to inflammable material, and its quietness in operation.

1276. *How are indoor lamps suspended?*

Two approved methods of arc-lamp suspension are shown in Fig. 420; at the left, the method for exposed wiring, and at the right the method for concealed wiring. In addition to the insulator at the top of the lamp, there should be one in the suspension hook or wire to serve as further protection. Each lamp on a constant-potential circuit should be protected by an inclosed fuse, which may be of the cartridge type mounted above the lamp, as shown at the left of Fig. 420, or it may be of any other approved form connected in the lamp circuit and mounted at a distance from the lamp. This latter method is the more convenient one when concealed wiring is used and accounts for the absence of protective devices in the sketch at the right of Fig. 420, the conduit and junction box there shown being merely for convenience in wiring the lamp into circuit.

Electrically Operated Valves*

By H. M. Gassman

Valves of 24 in. diameter and larger are usually operated other than by hand for the reason that generally such valves must be closed in a very short time, which is impossible by hand operation, and also because such valves are frequently located in out-of-the-way places and are more conveniently controlled from some operating point more or less remote from the valves.

As large valves usually control very important service connections it is essential that the electrical equipment of these valves be dependable. To guard against failures the valves should be inspected and tried out regularly, particularly where they are likely to remain in one position for long periods.

The power required to open a valve is a maximum when starting the valve from its seat. After the gate has been opened, say one-fourth, comparatively little torque is required to complete the operation. The proportion of starting to running torque varies with the construction of the valve, the amount of corrosion and the condition of the valve seat. When closing hydraulic valves under pressure, the starting and running torques are comparatively small until the valve is about three-quarters closed. From that point on, the pressure on the gate increases approximately as a square of the decrease in the opening; consequently the torque at closing in such cases increases rapidly but does not reach the value of the starting torque required to open the valve under the same pressure conditions.

To overcome the sticking of the valve when it is to be opened, the drive is sometimes provided with a lost-motion device so as to give a hammer blow when starting the valve from its seat. With alternating-current motors such lost motion also allows the motor to develop a high speed and therefore a greater torque before starting the valve from its seat.

Unless some provision is made for limiting the torque of the motor or controlling the circuit when closing the valve, it is possible to jam and injure the mechanism of the valve, making further operation difficult. A slip gear cannot be used for this purpose as the slipping torque in opening will be practically the same as when closing, unless the gear be designed to act in the closing direction only.

Where compactness is a consideration the motor is rigidly attached direct to or on an extension of the valve casing. The motor and drive should be so arranged that there will be ample room for hand operation. An inclosed motor is preferred on account of exposure to dampness, water and flooding, inclosing being permissible without affecting the size of the motor, owing to the intermittent service. Terminals and wiring also must be protected against water and any mechanical injury which might result while repairs are being made to the valve.

A valve should not be overpowered by a motor for the reason that there is considerable risk of damaging the valve, and should not be underpowered because it increases the chance of failure when the conditions are extraordinary. The correct size of motor for the valve will vary with the duty and the general conditions under which the valve operates.

Where there is any choice of system the direct current is preferred in order to secure the advantages of a series-wound motor, giving a high starting torque and increased speed under light load. The commutator and brushs, however, are apt to give trouble in damp or wet locations. The alternating-current motor best adapted to valve operation is the squirrel-cage type, because of its simplicity. The motor should be designed with a high resistance rotor to increase the starting torque.

For equivalent performance—that is, the same assurance against failure of the motor to operate the valves—the alternating-current motor should be from 20 to 40 per cent. larger than the direct-current motor. In such applications motor efficiency does not enter, but operating efficiency does, and therefore it is economy to put on motors of greater capacity than would be actually required under ordinary conditions.

For remote control the ideal arrangement is one which permits of automatically starting and stopping the motor by simply throwing a switch or controller and one that makes it impossible to start the valve in the wrong direction and wreck some part of the valve or mechanism.

Where valves require direct-current motors larger than can be thrown directly across the line without resistance, such resistance should be designed to give the maximum torque required to open the valve and be retained permanently in circuit. As the motor speeds up due to a decrease in load, a step of sufficient resistance should be inserted in series with the motor to prevent excessive speed at light load, to slow down the motor as the torque increases near the closing point and to limit the torque finally should the valve seat itself before the motor is disconnected from the circuit. There are various schemes for obtaining this result with a two-point reversing drum controller or with a pilot switch control in combination with shunt- and series-wound contactors. In either case,

*From a paper delivered at the Pittsburg meeting of the American Institute of Electrical Engineers, Apr. 25-27.

limit switches should be provided at each end of the travel.

For alternating-current motors the same general scheme can be used as this type of motor will not increase in speed appreciably with change in load, but the resistance in the stator circuit will also have the effect of limiting the torque in closing the valve.

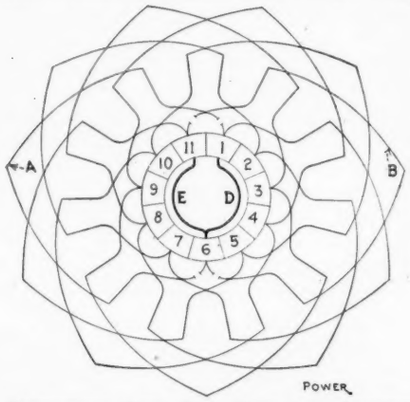
The limit switches can be designed to handle the motor current instead of the contactor exciting current. For small valves the limit switch is sometimes omitted and the motor allowed to increase its torque to the point of operating an overload circuit-breaker. Such an arrangement, however, is not foolproof in that it allows the operator to start the gate in the same direction at the end of its travel.

Detecting Defects in Armatures

By E. R. Parliman

In the Jan. 16 issue, Gordon Fox described a method for locating defects in direct-current armatures. In this connection he recommended the use of a U-shaped magnet for inducing a small electromotive force in the armature and then detecting the defects from bar to bar by means of a telephone receiver.

In the writer's opinion, the telephone test would be made much simpler by



Defective Coil Cut Out and Jumper Across Comutation Segments

using a battery and buzzer combination in place of the magnet. In making this test, place the terminals of the buzzer circuit over three bars on the commutator; then the terminals of the telephone receiver must bridge any two adjacent bars, between those in contact with the buzzer circuit. By revolving the armature, the receiver will record each separate coil in the armature winding.

There are three sources of trouble in a coil, a short-circuit, a ground and a coil having crossed wires. The indicator on the receiver with a short-circuit will sound dead when the receiver terminals bridge the commutator bar connected to the lead nearest to the short-circuit in the coil; while the bar connected to the other lead at commutator pitch distance will sound low.

The indications for a grounded coil will sound low on the bars connected with the defective coil and dead if one of the terminals of the buzzer circuit is placed on the armature shaft, while the other terminal remains on the armature commutator.

The best method, however, for testing out a ground is to place one terminal of a high potential circuit on the shaft while the other terminal is applied to each bar of the commutator successively. An arc will be produced when the second terminal makes contact with the bar connected to the grounded coil.

The indications for a crossed wire, commonly known as a crossed lead, will be very loud on the bars connected to the defective coil and low on the adjacent bars. A quick remedy for the short-circuited and grounded coils is to connect the defective parts with a "jumper"; for example, consider the four-pole, eleven-bar commutator armature shown in the illustration. Assume that in detecting the trouble, Nos. 1 and 11 sound dead, while bars Nos. 5, 6 and 7 sound low. Cut the lead *A* from bars 1 to 6 and *B* from bars 6 to 11, then cut the coil on the peripheral side, so that the coil, if grounded, will not become an isolated generator. The next step is to connect jumper *D* from bar No. 1 to bar No. 6 and jumper *E* from bar No. 6 to bar No. 11, so that the circuit will be complete.

This repair will not reduce the power to any great extent, as only two coils will be out of use, but if a number of coils were cut out the power would be reduced greatly.

This method in the second case might work temporarily, but the only systematic method to follow in such a case would be to install a new similar armature or rewind the old one.

LETTER

An Original Equalizing Connection

We recently installed a voltage-regulator panel, in addition to our switchboard, which called for the operation of the compound-wound exciters in parallel when both alternators are running or while changing over. The diagram in Fig. 1 shows practically how they were to be wired according to the blueprint.

After we had them wired as indicated, we started up exciter No. 2, and adjusted its voltage to equal the voltage of No. 1, which was running; on throwing in No. 2 exciter switch to put them in parallel, the polarity on No. 1 was reversed, "killing" the alternator excitation and putting out the lights all over town until we could throw in No. 2 alternator.

We had a double-pole double-throw switch connected as shown in Fig. 2 for charging batteries from either exciter, so by taking the positive lead and holding it on the positive terminal of No. 1 exciter, holding the negative lead on the negative terminal and closing the switch to No. 2 exciter for a few seconds, we got the polarity reversed back again.

We ran a couple of temporary wires from the lower contacts of the switch on the back of the board on No. 1 exciter to the alternator field rheostat, leaving the switch on No. 1 exciter out

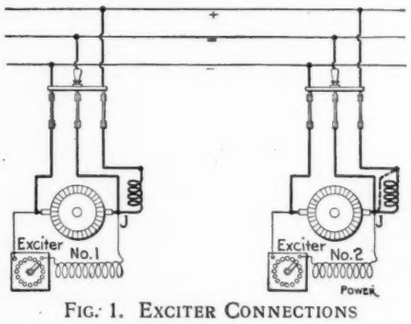


Fig. 1. Exciter Connections

to run the exciters separately and change the generators until we could locate the trouble.

On looking over one of my books I found a diagram that fitted our case and discovered that the equalizer wire should run from the junction of the series field terminal and the brush cable (*J*) to the middle pole of the switch. Instead of doing it that way, they ran a connection from the junction point *J* to the terminal of the series field winding, as shown by the dotted line in Fig. 1, on exciter No. 2, and left the middle pole of the switch free. I asked if that would not cut out the series field coil, and was assured they had tried that and it did not.

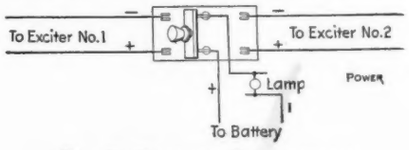


Fig. 2. Battery Connection

The manager took me over to exciter No. 1 that was running, and bridged across with a piece of wire as indicated by the dotted lines on No. 2.

"Now," he said, "you don't see the voltage vary any, do you?"

"Only about fifteen or twenty volts," I said.

After they had changed the connections to those shown by the solid lines everything was all right.

R. F. Calderwood.

Ida Grove, Iowa.

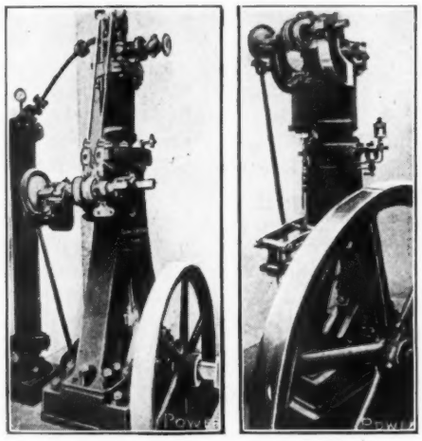
The diagram illustrating Mr. J. A. Croteau's letter on "Unexpected Wattmeter Readings" in the April 23 issue showed the two current transformers of wattmeter No. 2 on the same line. This is incorrect; instead, one transformer should be on the first line and the other on the second line.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

Present Status of the Diesel Engine

Following his election to honorary membership in the American Society of Mechanical Engineers on Apr. 30, Dr. Rudolph Diesel, inventor of the well known engine bearing his name, delivered a lecture upon "The Present Status of the Diesel Engine." While the general scope of the lecture was along much the same lines as his London address of some weeks ago and many of the points had been brought out from time to time in the technical press, still the paper covered in logical order the development of the Diesel engine from its inception to its present position as an important commercial factor. Furthermore, many points were brought out which are not of common knowledge, especially as applied to American practice.



FIGS. 1 AND 2. FIRST AND SECOND EXPERIMENTAL DIESEL ENGINES

FUEL

By way of introduction, Dr. Diesel pointed out the influence which his engine is having upon the coke and gas industries in Europe, the byproducts from these, such as tar and creosote oils as now produced, being especially adaptable for use in the Diesel engine. Of course this is not of so great importance in the United States on account of its richness in natural oil, but it is of utmost importance in those countries which have practically no oil production of their own. For instance, it is estimated that the tar production of Germany is sufficient for furnishing approximately 1¾ million hp. for 300 days of 10 hr. each per year.

Dr. Diesel also called attention to the fact that it is possible to use vegetable and animal oils in his engine, a fact not generally known. While this is insignificant at present, in the course of time it may play an important part.

EARLY HISTORY

Reverting to the early history of the engine, Dr. Diesel stated that the first attempt brought forth a vertical four-stroke-cycle engine constructed in 1893 (Fig. 1). This was fitted with a piston rod and external crosshead, the cylinder having no water jacket and the camshaft placed low with the valves actuated by means of long rods. There was no air-supply pump and the fuel was injected directly. This engine never ran, but at the first injection of fuel an explosion occurred and the indicator went to pieces. It served to prove, however, that it was possible to compress air so high that the fuel injected into it would ignite and burn.

The second engine (Fig. 2) had a water-jacketed cylinder and the camshaft was placed higher. Furthermore, it was fitted with an air pump. This engine also would not run.

Fig. 3 shows the first successful Diesel engine. This was constructed at Augsburg in 1897 and developed 18 hp. It had the piston connected to an external crosshead and worked on the four-stroke cycle.

FIG. 3. FIRST SUCCESSFUL DIESEL ENGINE

COMMERCIAL FOUR-STROKE-CYCLE TYPES

A few years later the external crosshead was abandoned and the trunk pis-

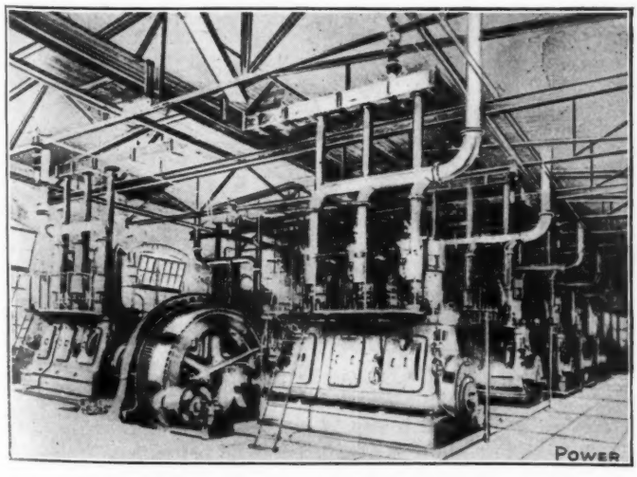


FIG. 4. PLANT OF PRAIRIE PEBBLE PHOSPHATE CO.

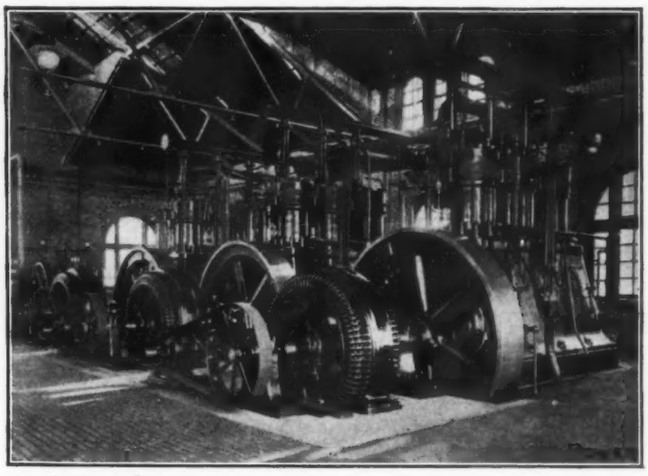


FIG. 5. PLANT OF UNITED GAS IMPROVEMENT CO.

ton adopted. Engines of this design having cylinders of 10 to 250 hp. each were constructed and by adopting the multi-cylinder type as high as 1000 hp. per engine was attained. These ran at comparatively low speed, from 160 to 200 r.p.m., and were of heavy construction. Gradually the sizes were increased, although the general design remained the same.

of this kind are now built up to 700 hp.

After the vertical engines had been in use for about 12 years, horizontal four-stroke-cycle engines were built. At first these were practically vertical engines laid on their sides without any independent structural innovations. Gradually, however, the details were altered in such a way as to render them more suitable for a horizontal position, and a type

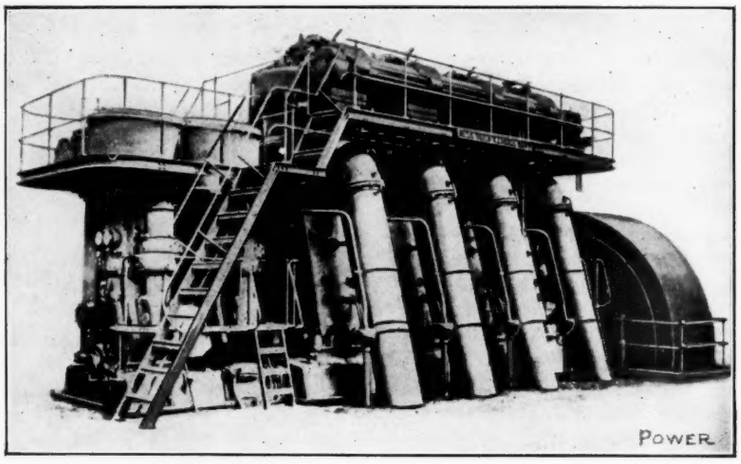


FIG. 6. LARGE TWO-STROKE CYCLE ENGINE

gine into the United States and after it had proved successful here this departure

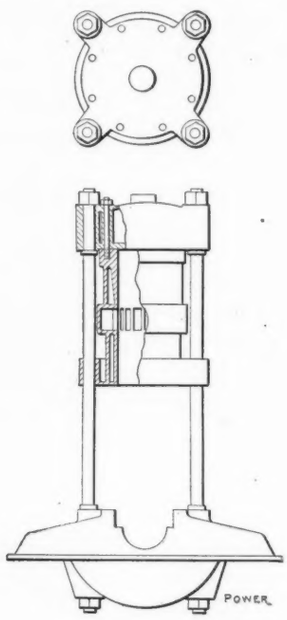


FIG. 7. LARGE CYLINDER UNIT ARRANGED TO ALLOW FOR EXPANSION

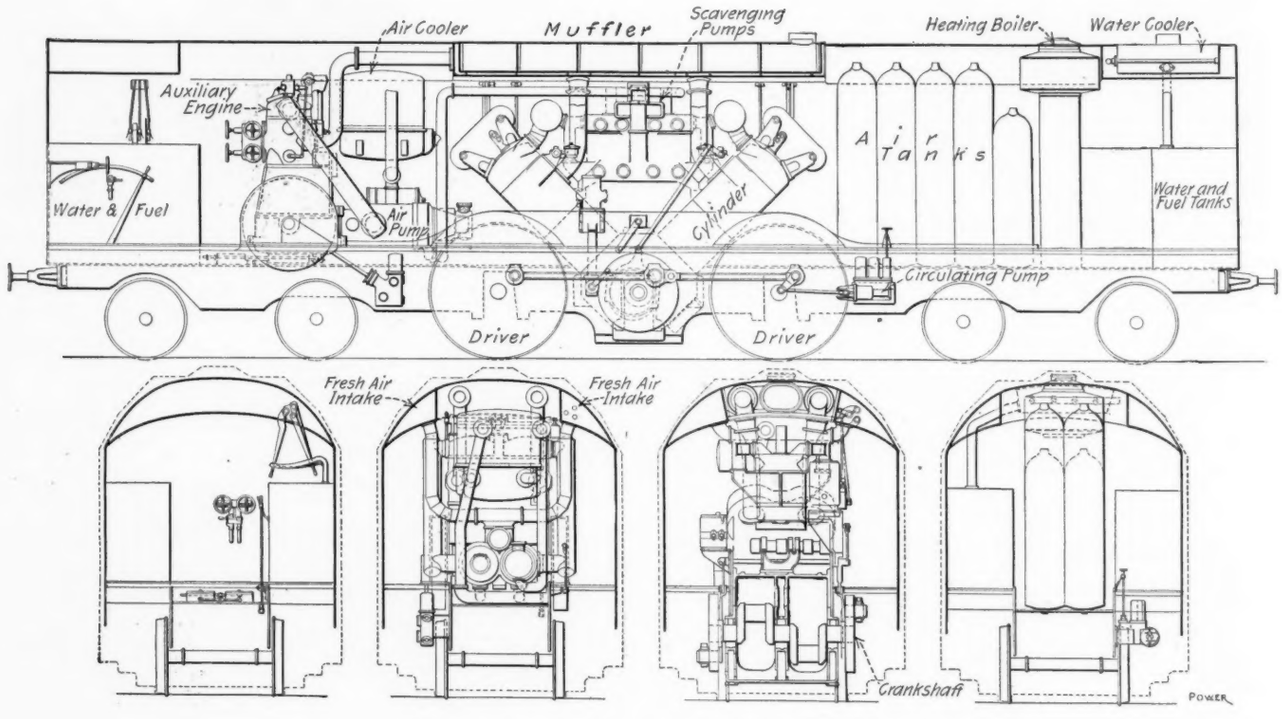


FIG. 8. GENERAL LAYOUT OF DIESEL LOCOMOTIVE

As the central stations took up the Diesel engines, the necessity arose for higher speeds. Accordingly, engines were built with speeds ranging from 300 to 600 r.p.m., the principal difference between these and the earlier type being that the cylinders were supported by light steel columns instead of heavy cast-iron frames. This reduced the weight considerably. Four-stroke-cycle engines was evolved resembling very closely the horizontal gas engine. Double-acting four-stroke-cycle horizontal engines with two or four cylinders arranged tandem are now built in sizes up to 2000 hp.

AMERICAN PRACTICE

The abandonment of the crosshead and the adoption of the trunk piston began with the introduction of the Diesel engine into the United States and after it had proved successful here this departure was followed by the European builders. Other modifications adopted in American practice were a closed base frame, valves in a chamber at the side of the cylinder instead of in the head and an independently driven air pump. Some of these modifications have now been adopted in European practice and others are about to be.

Dr. Diesel stated the aggregate of

Diesel engines in the United States is at present about 300 units, having a combined horsepower of 150,000. He then showed views of a number of these plants. The largest is that of the Prairie Pebble Phosphate Co. at Mulberry, Fla. This is shown in Fig. 4 and comprises sixteen Diesel engines arranged in eight double units of 450 hp. each, and served by five air compressors.

Another important American Diesel engine plant is that of the United Gas Improvement Co. in Philadelphia. This is shown in Fig. 5 and has three 225-hp. engines.

Two-stroke-cycle Engines

It will be remembered that in the Diesel engine the scavenging is not done with a mixture of fuel and air, but with pure air; thus one source of fuel loss is avoided, making this type especially adaptable to the two-stroke cycle. Dr. Diesel admitted, however, that the four-stroke-cycle engine was still the more efficient, due to better combustion. On the other hand, the two-stroke-cycle engine, owing to its smaller cylinders, has come into favor for stationary plants of higher power and for marine work. Two types of the two-stroke-cycle engine have so far been in competition. That built by Sulzer Bros. has a separate scavenging pump and the other, built by the Maschinenfabrik, Augsburg, Nürnberg, has the scavenging pump, which has an annular piston, placed underneath each combustion cylinder. Both engines are single acting. A four-cylinder two-stroke-cycle Sulzer-Diesel engine of 2400 hp. is shown in Fig. 6.

Marine Engines

In reviewing the application of his engine to marine practice, Dr. Diesel stated that at the start attempts were made to make the four-stroke-cycle engine reversible. This resulted in a very complicated mechanism, and, although a few of these are still being built, this type has almost entirely given place to the reversible two-stroke-cycle engine, which for marine work also embodies other advantages, such as less weight, etc.

Very important experimental work is now being carried on for the purpose of developing high-power marine engines with cylinder units reaching 1000 to 2000 hp. In this connection Sulzer Bros. have just completed a single cylinder of 2000 hp. with single-acting piston based on the construction shown in Fig. 7, which permits free expansion of the cylinder under the action of high temperatures.

Dr. Diesel stated that there were at present 365 ships fitted with Diesel engines. One of these, around which popular interest centers, is the "Fram," in which Capt. Amundsen made his successful trip to the south polar regions.

Also two submarines for the United States Navy are being fitted out with Diesel engines.

Diesel Locomotive

One of the most interesting points covered by Dr. Diesel's lecture was the application of his engine to locomotives. This is an entirely new phase of the subject and, although experiments have been in progress for the past five years at the Winterthur works of Sulzer Bros., practically nothing has heretofore been made public regarding it.

The first locomotive, which is of 1200 hp., has just been completed and is at present undergoing tests. This is represented in Fig. 8. The application of the Diesel engine to locomotive practice presented a rather difficult problem, owing to the difficulties of maneuvering with this type of motor and to the limitations in space and weight.

Referring to Fig. 8, the motor is a two-stroke-cycle Diesel engine with four inclined cylinders set in pairs at an angle of 90 deg.; the cranks, however, are set at 180 deg. to afford a balancing effect. Between the working cylinders are placed two scavenging pumps driven by links from the connecting-rod. At one end of the car is placed an auxiliary engine which drives the horizontal air pumps. These serve to increase the power of the main engines when starting, maneuvering and going up hill, in such a way that auxiliary compressed air and oil fuel are supplied to the cylinders. For ordinary running the engines work like an ordinary Diesel motor.

Air-storage tanks are provided for supplementing the work of the auxiliary pumps. At the top of the car at one end is a device for cooling the circulating water, and for heating the train a small donkey boiler is installed. The total weight of the locomotive is about 85 tons and the outcome of the tests now being made upon it is awaited with keen anticipation.

To substantiate the claims made for his engine, Dr. Diesel produced a set of curves (Fig. 9), showing a comparison between an ordinary noncondensing plant, a condensing plant, a producer plant and the Diesel engine, all based on the heat consumption per unit of power per hour. This unit was a "pferdekraft," which is equivalent to 0.9863 hp. in English units.

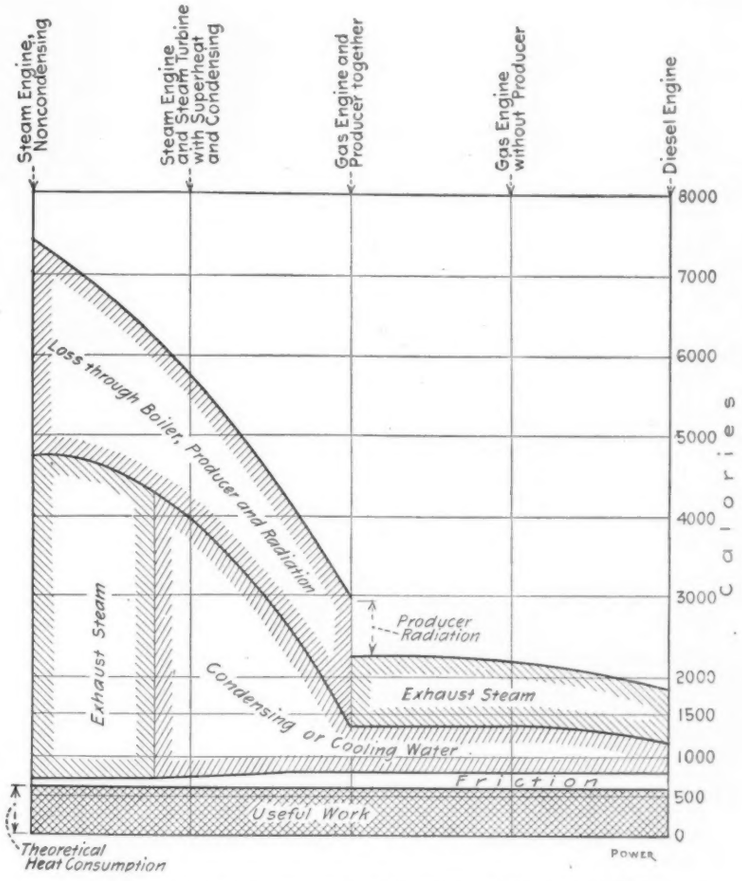


Fig. 9. Heat Distribution in Different Types of Plant

The American rights to the later Diesel patents (the early ones having expired) have been taken over by the Busch-Sulzer Bros. Diesel Engine Co., of St. Louis, who are now erecting a large plant capable of turning out many thousand horsepower in Diesel engines yearly. We are indebted to this firm for the illustrations herein shown.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Heating and Ventilation of New Bosch Factory

The Bosch Magneto Co., of New York, has erected at Springfield, Mass., a factory for the manufacture of Bosch products. The plant is located between North Main St. and the Boston & Maine R.R. and at present comprises the manufacturing building, the power house and the boiler house, besides a number of smaller temporary buildings. The buildings are arranged to form a large block,

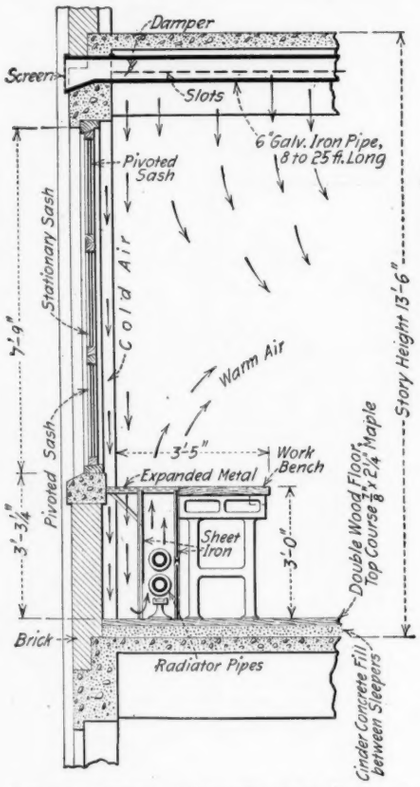


FIG. 2. TYPICAL WINDOW, RADIATOR AND WORK BENCH ARRANGEMENT

inclosing two light courts in which the power and heating plants will be located.

HEATING

Heating is effected by what may be termed an indirect system. It uses air as the convecting medium, but it differs from the ordinary system of indirect heating in that instead of one large heater through which the air is forced with great velocity, there are a great many ordinary radiators along the outside walls, around which the air travels rather slowly. The radiators are supplied with low-pressure steam, the condensation returning to the boilers by gravity. Two cast-iron sectional boilers, each of 30-hp. capacity, supply the steam. The boiler house is placed entirely underground.

The gases of combustion pass through economizers, Fig. 1, where a part of their

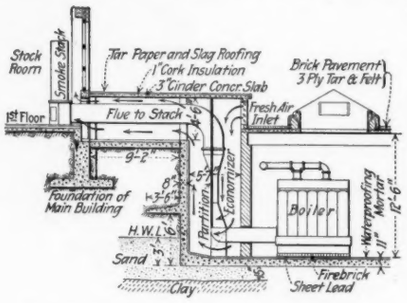


FIG. 1. SAVING HEAT OF FLUE GASES

heat is taken off and they are then led to the smoke-stacks erected within the main building. In this way a great part of the heat from the gases is utilized. An enclosure about 9 ft. high on each floor protects the workmen against the direct radiation of the smokestacks. The warm air coming from the economizer room is used to heat the stock room on the first floor, which is next to the boiler house and occupies about one-quarter of the floor. As the amount of heat furnished by the economizers is much greater than necessary for the stock room, part of the warm air will be piped to the upper stories.

The radiators are made up of cast-iron pipes with radiating fins to increase the heating surface. The arrangement of the radiators may be seen in Fig. 2, which shows a cross-section through the outside wall at a window. The radiator is separated from the outside wall by a partition of sheet metal which extends from the window sill to the lower part of the radiator. It is also separated from the interior of the room by a partition running from the window sill to the floor. The two partitions together with the outside wall form a casing with two separate spaces covered on top by expanded metal. When the radiator is heated the surrounding air will rise in the inner space and draw the cold air through the space next to the wall. The cold air comes through the outer space and rises in the inner space of the radiator casings. The warm air leaving the casing is drawn away by the suction caused by exhaust fans located in the main-stair tower.

This arrangement of the radiators has a number of advantages over the old method of setting them directly against the wall. The losses of heat through the walls and windows are reduced and the lower part of the wall is protected against direct radiation.

The work benches can be set directly against the radiator casings as the rising warm air protects the workmen from draft and cold and the inner walls of the casings keep off the direct radiation.

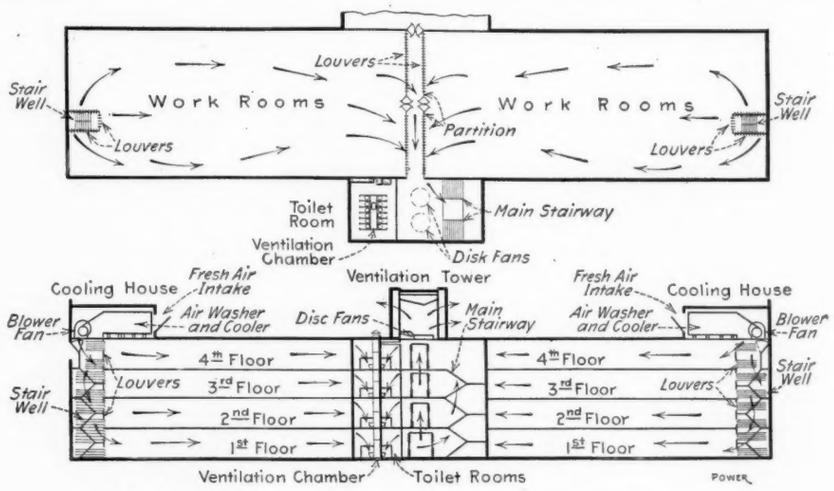


FIG. 3. GENERAL OUTLINE OF VENTILATING SYSTEM

VENTILATION

The buildings are ventilated by mechanical draft. See Fig. 3 for the general arrangement. The stairwells are used as ventilating flues, and the exhaust fans, Fig. 4, are placed near the top of the stairwell. There are two disk fans at the top

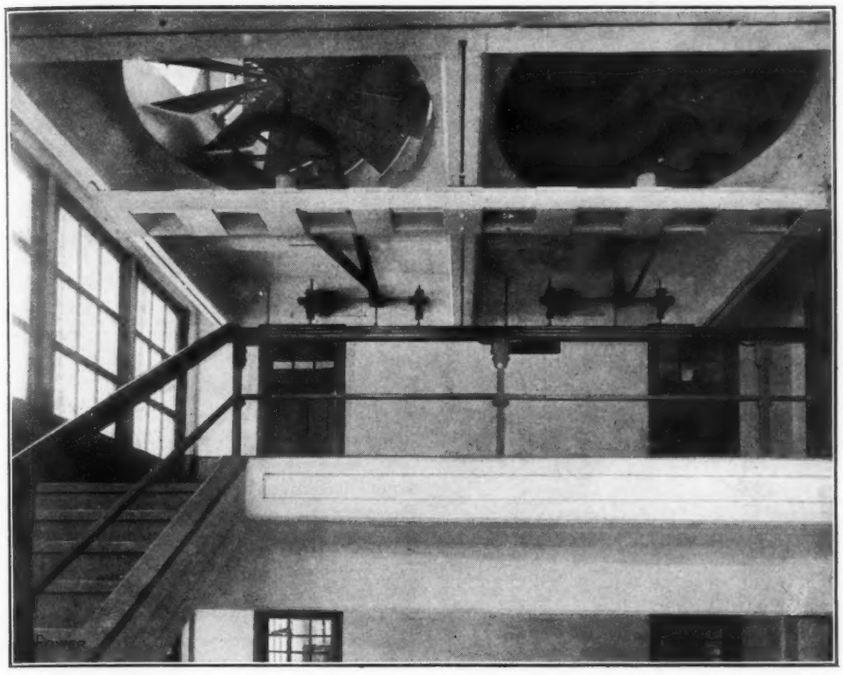


FIG. 4. EXHAUST FANS IN MAIN STAIR WELL

of the main stairway, each having a maximum capacity of 100,000 cu.ft. per minute. The discharging capacity of the two fans together can be varied from 50,000 to 200,000 cu.ft. a minute. A blower fan of 30,000 cu.ft. capacity is placed over each of the other two stairways, on the north and south ends of the building. The direction and intensity of the flow of air through the workrooms to the exhaust fans are regulated by louvers, see Fig. 5, which are placed in the partitions that divide the working rooms of the main building. These partitions divide each floor into two parts, forming a passage way between, running from the main stairs to the wash rooms. Louvers are also provided in the walls of the stairways on the north and south ends.

The ventilation of the forge room and the men's toilet room on the first floor and the hardening room on the second floor is separate from the general ventilation to keep the fumes and gases out of the general work rooms. Two blower fans draw the air from these rooms and carry it through a chimney flue on the roof into the open air.

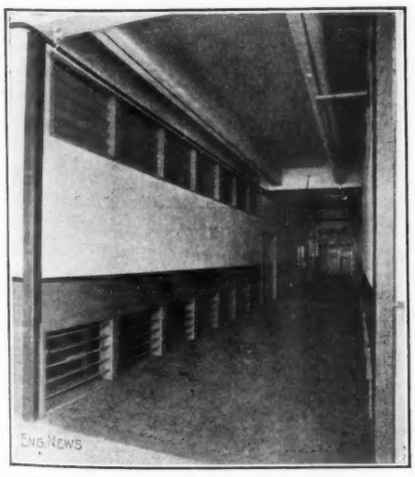


FIG. 5. VENTILATING LOUVERS IN CORRIDOR

The operation of the general ventilating system can be varied, depending on weather conditions. In winter the disk fans in the main stair tower are used only for producing a change of air twice every hour. Part of the fresh air enters through the walls and the joints of the windows; the rest is taken in through galvanized-iron pipes which run along the ceiling and through the outside walls into the open air. The pipes are of 6-in. diameter and vary in length from 8 to 25 ft. according to their distance from the main stairs. The cold air enters the rooms through a number of thin slots in the pipes, shown in Fig. 6, and in dropping mixes with the warm air that is constantly rising. The temperature in the rooms is therefore kept very uniform and the heat is used to the best advantage.

The air is drawn toward the center partitions and escapes through the bottom louvers into the stairwell, from where it is drawn out by the fans. The fans discharge the foul air into a chamber on top of the roof, where it passes into the open. This ventilating system has been in operation during the past winter, and, in combination with the heating system, has proved to be very satisfactory. Although the loss of heat from the ventilation is considerable, the consumption of fuel is well within the expected limits, a fact largely due to the insulating effect of the double-glassed windows, the radiator casings and the heat-saving arrangements of economizers, smoke-stacks and air-intake pipes.

As the weather becomes warmer and the windows can be opened, the change of air is gradually increased. If the two blower fans over the small stairwells are used as exhaust fans, together with the two disk fans in the main stairwell, it will be possible to change the air 12 times an hour; the draft near the windows will be quite perceptible if the opening of the windows is properly regulated. This can be easily done, as they are controlled by unit drives and cannot be opened by the workmen.

In hot weather, the exhaust fans in the main-stair tower will run during the early morning hours and will draw the cool night air through the building. Thus the interior of the building will be cool in the morning and the effect of the cooled concrete columns, beams and floors and the metallic contents of the buildings will help considerably in keeping down the temperature of the interior air.

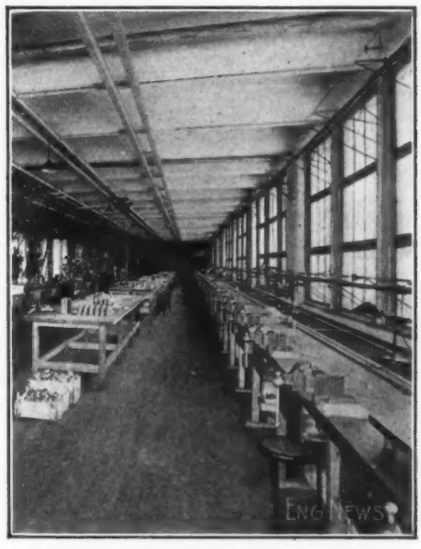


FIG. 6. SLOTTED FRESH AIR PIPES

During very hot weather, a change of air would not be of advantage, the temperature of the outside air being so high that it would offer no relief to draw it into the building. When such conditions prevail, it is intended to close all windows, bring the fresh air in through the two stairwells at the north and south ends of the building, and cool this air before it enters the work rooms. For this purpose, two air-cooling machines are installed, one on top of each stairwell. The cooling machines, one of which is shown in Fig. 7, are of the water-spray type. The air is taken in through an opening in the penthouse, enters the cooling machine, is drawn through the water spray, passes a number of baffle plates, where it loses its

free moisture, continues through the fan into the stairwell and passes from there through the louvers into the work rooms. After it has circulated through a work room, it leaves through the upper louvers in the center partitions, and is drawn into the main stairwell and exhausted. The water for the air-cooling machine is taken from the well at the rate of about 60 gal. per min. for each machine and at a temperature of about 54 deg. F. With that quantity of water, it is guaranteed by the manufacturer of the cooling machines that air entering at 95 deg. F., and containing 9.3 grains of moisture per cubic foot, will be cooled to 78 deg. It is calculated that under these conditions, it will be possible to keep the temperature inside of the building about 9 deg. lower than the outside, changing the air four times an hour.

While the ventilating and heating apparatus have been tried out during the past winter, it has not been possible to operate the cooling machines. As this is practically the first attempt that has been made to cool large work rooms with a view to improving conditions for the workmen of a factory during hot weather, it is expected that a number of complications might arise that will make the problem more difficult than it appears, but it is thought that with the ventilating machinery as now installed, it will be possible to overcome these difficulties.

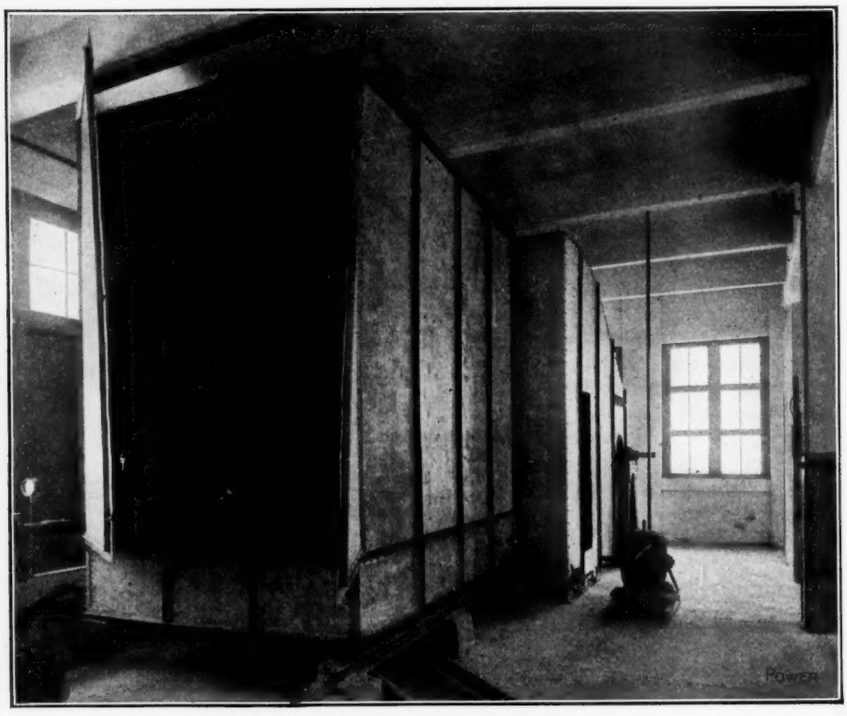


FIG. 7. AIR COOLING MACHINE

POWER PLANT

The machine tools are arranged for group drive. The mainshafts are about 60 ft. long, each being driven by an induction motor of 10-, 15- or 20-hp. capacity. Electrical energy is supplied at present by the United Electric Light Co., of Springfield. A private power plant, located in the power house, is in course of erection, consisting of a 280-hp. Diesel engine connected to a 200-kv.-a. Westinghouse generator, which will furnish current for both power and light. When this plant is completed, it is intended to use the outside supply as a reserve.

Arrangements have been made so that the load can be distributed between the two supplies at any ratio without running the two systems in parallel.

CORRESPONDENCE

Why Does the Pump Race?

I have occasionally had duplex pumps knock and race as described by Mr. Moulton in the Apr. 2 issue. The fundamental reason underlying this is that the pump does not carry its water to the end of the stroke; consequently there must be gas, steam or vacuum present in the water cylinder. As this condition will not present sufficient resistance to the steam, the pump will knock on the end of strokes and race.

Mr. Moulton says he shuts off the steam heat and opens the vacuum breaker.

This will lower the pressure on the water and it will immediately develop steam, particularly in the pump-valve chambers and in the suction pipe; this is why the pump gets steam instead of water and is the direct cause of the trouble. The obvious remedy is to keep the tank at a uniform pressure.

I do not see the necessity for the equalizing tank; a regulating float valve could have been used in the large tank.

W. A. COOIL.

Ladysmith, B. C.

In the light, power and hot-water heating plant where I am employed we have a battery of four boilers bleeding live steam into three exhaust condensers and live steam only into No. 4 condenser for heating.

The condensation from No. 1 condenser goes into an open feed-water heater while from Nos. 2 and 3 it goes into an open tank, and the suction pipe from the open heater and tank is connected together under the floor.

When live steam is shut off in Nos. 1, 2 and 3, or city water is turned into the heater, a partial vacuum is formed in the heater, drawing the water away from the open tank and closing the throttle on the pump till conditions become normal again. This pump never races.

The condensation from No. 4 goes into a closed tank and then to No. 2 pump. This pump is also controlled by a throttle operated by a float valve in the tank.

When too much steam is shut off at once a partial vacuum is formed in the tank, preventing the water from flowing to the pump, which causes it to race. By shutting off just a little steam at a time no vacuum is formed.

We do not use an equalizer such as Mr. Moulton shows in his diagram. If he would disconnect the equalizing pipe from both return and equalizing tank, and leave the equalizing tank open to the atmosphere, it would prevent the pump from racing provided there is no pressure in the return tank.

R. F. CALDERWOOD.

Ida Grove, Iowa.

Germany Honors Fair Commission

On May 7 the Panama-Pacific Exposition Commissioners were received in Berlin, Germany, by distinguished government officials and invited to explain the purpose of the fair.

Chairman John Hays Hammond said the commissioners' visit to Germany was merely to familiarize that country with the scope of the enterprise and they did not ask any definite promise of participation.

The officials evinced a lively interest and marveled at the work which has already been accomplished since the San Francisco fire six years ago. It is believed that the plans for the coming exposition will be favorably considered in Germany and that its people will actively participate in the exhibits shown by other European governments.

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POWER

Diesel Engine in the United States

Why the Diesel engine, with its high efficiency, has not been used more extensively in this country is a question often raised. While there are more of these installations than has been generally supposed, as reference to the article elsewhere in this issue will show, still the number of Diesel engine plants in the United States is comparatively small.

Many have tried to account for this by asserting that the workmanship here is inferior to that in Europe and that the operators are less skilled. Dr. Diesel, however, during his recent visit, refuted this statement. He claimed that the Diesel engines built in this country, after having passed the necessary manufacturing apprenticeship stage, are quite as good as those of European make; furthermore, they are handled as intelligently. In his opinion, the question is purely economic.

In Europe the leading idea seems to be operating cost while here it is first cost. This may be explained partly by the facts that our rates of interest are higher, coal much cheaper, and steam engines cheaper than in Europe. The Diesel engines, owing to their necessarily heavier proportions and special features of design, are expensive.

Moreover, in American practice obsolescence is a factor to be reckoned. Improvements in prime movers have been so rapid that it is common to see machines, although in perfect operating condition and only eight or ten years old, being displaced by those of the latest design. Under such conditions it would be unwise to invest heavily in apparatus which would be superseded in a few years. Therefore, American engineers seem to have been content to watch developments until the Diesel engine has reached a stage of perfection such that would warrant the increased investment.

Within the past two or three years, however, conservation and "efficiency" have been impressed upon the American public to such an extent that it is reasonable to assume that more attention will henceforth be given to economy in production. This will undoubtedly open the field for the Diesel motor.

The Size of Pipe

When installing a heating system, one of the largest items of the initial investment is the cost of the piping. Any reduction in diameter means a considerable saving, so that the arrangement which will deliver a certain amount of heat through the smallest pipe has an advantage which would naturally tend toward its selection.

It is frequently claimed, and quite generally believed, that the supply main of a vacuum system need not be more than half, or at most two-thirds, the size of the main required for a system having an initial pressure above atmosphere. Providing the latter has been properly designed and provision is made for removing air, it is difficult to see why this should be true.

When the pressure of steam close to the zero mark on the gage is reduced, the volume increases rapidly and will require a more rapid flow for the same delivery. The friction varies nearly as the square of the velocity, the latter being due to the difference in pressure between the terminal and initial points less the friction head. As a vacuum system is generally intended to reduce back pressure and the return is cooled to produce a difference in pressure below the initial point, why should there be any reduction in the size of main with the corresponding increase in volumes and reduction in temperature?

Suppose an initial pressure of five pounds gage were used in one case and atmosphere in another, the volumes would be 20.44 and 26.79 cubic feet per pound respectively, with a difference of only six heat units in favor of the higher pressure. This would indicate that for the same loss in friction and output in heat units the lower pressure will require a main nearly one-third larger rather than one two-thirds the size.

Of course, air in the system is a factor which must be considered, and not

infrequently it operates to the disadvantage of an improperly arranged system.

A case in point is a certain plant which had a ten-inch main. Due to the arrangement of the piping, there was excessive back pressure, so that the radiation became air-bound and did not receive sufficient steam to heat the building properly. A vacuum system might have cleared the radiation of air, restored the circulation and perhaps showed that a six-inch main would be all that was required for the work. This simply means, however, that a smaller pipe under pressure would have handled all the heat units actually transmitted and is no argument for smaller mains under conditions of lower pressure and greater volume.

Should an Engineer Purchase Instruments?

The letter on page 782 of this issue under the above heading has an excellent suggestion.

True, this question will long remain open, but many who argue negatively lack foresight rather than ambition, and this partially explains their attitude. There are thousands of engineers who either continuously or intermittently have eight or more leisure hours every day, and while many spend them in endeavoring to increase their earnings, some become discouraged if a suitable channel of activity does not suggest itself. As suggested in the letter, the ambitious engineer could make tests in neighboring plants, profitably using his idle hours and gaining prestige and reputation.

A complete indicator outfit may be purchased for from forty to sixty dollars, a three-pipette Orsat for about thirty-five dollars, and a satisfactory flue-gas sampling outfit can be easily made by almost any engineer. The cost of handbooks is not prohibitive, and a few will answer one's needs. It does not require much knowledge of chemistry or extensive paraphernalia to make practically accurate tests of boiler waters, or to effect their cure. Much of the apparatus can be made at home or in the shop.

An engineer could equip himself for test work for about one hundred dollars, and there are concerns which will willingly pay well for it, and add a bonus if the results justify it.

Allowable Boiler Pressure

At a recent meeting of boiler inspectors the discussion of pressures allowable for steam boilers brought out some interesting facts.

Frequently a boiler built to withstand a working pressure of 125 pounds per square inch is operated at 100 pounds pressure. This may be because an underloaded engine, with the higher steam pressure, will expand the steam in the cylinder below atmospheric pressure and produce what is known as a negative loop on the indicator diagram. Running the engine with a reduced steam pressure will eliminate this undesirable condition. Here is where the engineer and the boiler inspector disagree. The inspector is quite apt to conclude that if only 100 pounds pressure is required to operate the plant, the boiler should be limited to that pressure. This is certainly on the side of safety, but it is hardly a scientific method of dealing with the question.

Engineers object to any reduction in the allowable pressure because they realize that, some time, it will be necessary to maintain the highest pressure the boiler can safely carry. Experience has taught them that it is easier to regulate the safety valve to blow at 100 instead of 125 pounds pressure than it is to induce the inspector to increase the allowable pressure from 100 to 125 pounds. Therefore, while favoring reducing the actual boiler pressure where economy will be improved, they do object to the inspector changing the allowable pressure carried.

One inspector stated that he allowed all the pressure a boiler would, according to his judgment and calculation, carry, and set the safety valve so close to the working pressure that it would frequently operate, thus preventing the valve from becoming inoperative through nonuse. This is good practice; it would be inviting disaster to reduce the boiler pressure to 100 pounds per square inch and have the safety valve set to operate at 125 pounds. On the other hand, there is no good reason why a boiler should not be allowed to carry 125 pounds per square inch, although it has been working at a less pressure, providing it can safely do so.

In some cities it is almost impossible to get permission to increase the working pressure after running with a lower one. There is no apparent reason for this attitude on the part of an inspector, unless it is a desire to err on the side of safety, which, however, is likely to put the plant owners to unnecessary inconvenience and perhaps to the expense of installing a new boiler.

Talking and Doing

Discussing ways to better the conditions of power-plant employees is some good if it sets them thinking. No real and permanent benefit results, however, until the thinking develops into action. A vaccination does not count until it "takes." POWER is long on suggestions as to what should be done, and how, but short on letters telling what has been done.

We have tried to inoculate our readers with ambition to advance themselves and improve their surroundings. Now it would be a vindication of our preaching and an inspiration to those who have not applied it yet, to hear from those who have.

Perhaps our sermons had nothing to do with your success. Never mind, we are not looking for glory, but if the principles we are advocating are right, support us. Write us how you conquered difficulties, what your greatest help was, and anything else that will encourage the fellow who is still at the bottom of the ladder and not very confident of his climbing ability. Do not let modesty keep you from giving others the benefit of your experience.

We maintain that the power-plant employee, if he really expects to ultimately reach one of those better places at the top, must improve his spare time by keeping alive to the advance in his field and, being well grounded in such knowledge, must have the courage to let it be known.

"Example is better than precept." If you are one of the successes whose experience confirms our statements, a few words from you will do more good than all our moralizing.

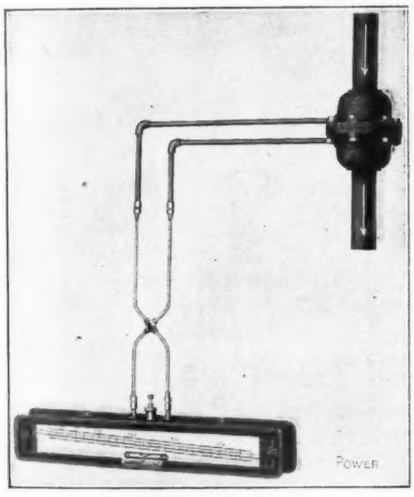
Engineering for Apr. 25 reports a turbine test in which a kilowatt-hour was developed on 11.1 pounds of steam. This would be the record if true, but the original data gives a consumption in metric units equivalent to over 12 pounds.

Gas Economy Indicator

The accompanying illustration shows a gas economy indicator, which is manufactured by the Meriam Co., 5606 Euclid Ave., Cleveland, Ohio.

An orifice casting is placed in the gas or air-supply line and is connected with ⅛-in. pipe to the indicator, which is practically a U-tube and operates on the same lines as a draft gage, the difference in pressure being a measurement of inflow.

The pressure on both sides of a copper disk in the orifice casting is transmitted to the opposite ends of a glass tube containing a red liquid. The flow of gas through the orifice is indicated on a graduated scale by the movement of the red liquid, and is shown in cubic feet per hour. This device enables a gas-engine operator to detect any irregularities in the gas consumption, and to regulate the engine for the most economical and efficient operation.



GAS ECONOMY INDICATOR

Any changes or adjustments in the ignition or mixture will instantly be shown on the indicator by the movement of the liquid, and will indicate whether these changes have improved the economy. After once determining the adjustment at which the engine operates most economically on a given load, should the indicator at a subsequent time show a greater consumption of gas with the same load, this would indicate a waste of gas caused by either foul or defective spark plugs, leaking pistons or valves, or improper adjustment.

Two types of instruments are manufactured, one containing a single tube for use with engines operating on natural or artificial gas, and the other containing two tubes for use with engines operating on producer gas, one of the tubes being for gas and the other for air.

In addition to using the instrument on gas engines, it may be adapted for use with gas producers, and in fact any place where it is desirous of knowing the exact flow of gas or air, so that it may be kept at a fixed rate, regardless of the pressure.

McEwen Centrifugal Pump

The most notable feature of this pump is its radical departure from the ordinary type of turbine runner, and the substitution of a runner of either helical or propeller type, depending upon the head and the speed. The general construction is otherwise modified to better meet the demands of high speed.

Water enters the suction inlet and flows in a spiral path through a volute suction passage where it is parted to flow equally into each side of and naturally balance the impeller as shown in Fig. 1. The water is delivered from the periphery of the impeller into a volute

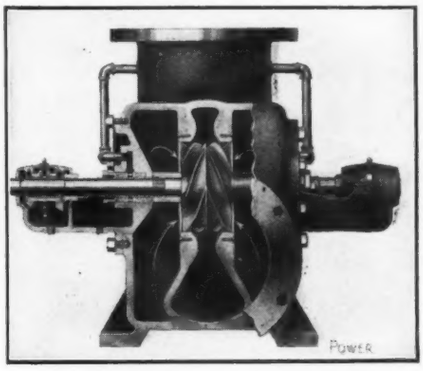


FIG. 1. BALANCED IMPELLER

outlet chamber through the discharge outlet, shown in Fig. 2. To compensate for possible inequalities and abnormal conditions, thrust collars are provided on the inner ends of the bearings. The impeller is allowed to find its own center during a running test; the collars are then set and thereafter hold the impeller in the position of highest efficiency.

The outer edges of the vanes are helices, while the main body of the impeller consists of two cone frustums with opposed bases. The water is thrown from the impeller at a velocity required by the head, and in streams which have parallel flow through the throat and annular nozzle into the volute, and the velocity is there converted into pressure.

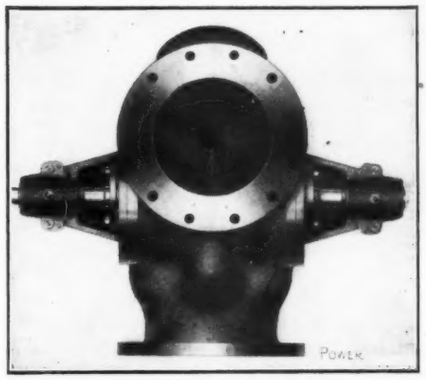


FIG. 2. DISCHARGE OUTLET

Where desirable to maintain steam-

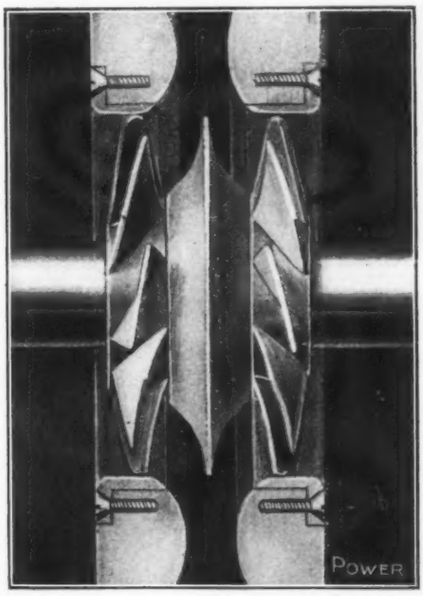


FIG. 3. PROPELLER TYPE IMPELLER

turbine speeds at the low heads of 5 to 20 ft., the helical blades of the standard impeller are replaced by blades of the propeller type which are really helical blades cut short and given an increased pitch to suit the head required. They are shown in Figs. 3 and 4. The cone body of the helical impeller serves as a deflector for the propeller. The two types of impeller are interchangeable in the same casing. An end view of the discharge chamber is shown in Fig. 5.

The interior of this pump is accessible

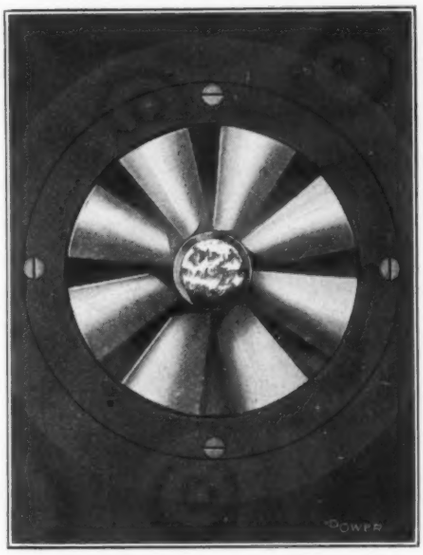


FIG. 4. END VIEW OF IMPELLER

without breaking the pipe joints, and the removal of the impeller involves only the breaking of a small ring joint and removing one bearing head.

The shell is cast in one piece, ma-

chined and provided with renewable bronze wearing rings where the impeller runs close. The impeller is made of bronze, and is built up of two halves. The outer edges of the blades are machined to a running clearance with the wearing rings in the shell. The shaft is of nickel-steel and is entirely protected from the action of water by bronze protecting sleeves. The possibility of wear, due to the binding of the packing at the stuffing-gland is made unobjectionable as the wear comes on renewable sleeves. The compactness of the pump is shown in Fig. 6.

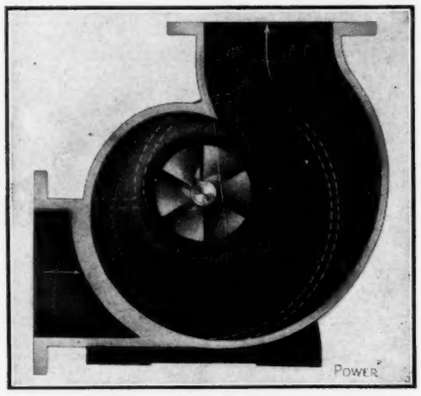
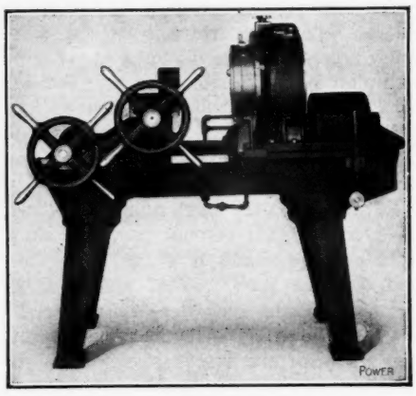


FIG. 5. DISCHARGE CHAMBER



PIPE THREADING MACHINE

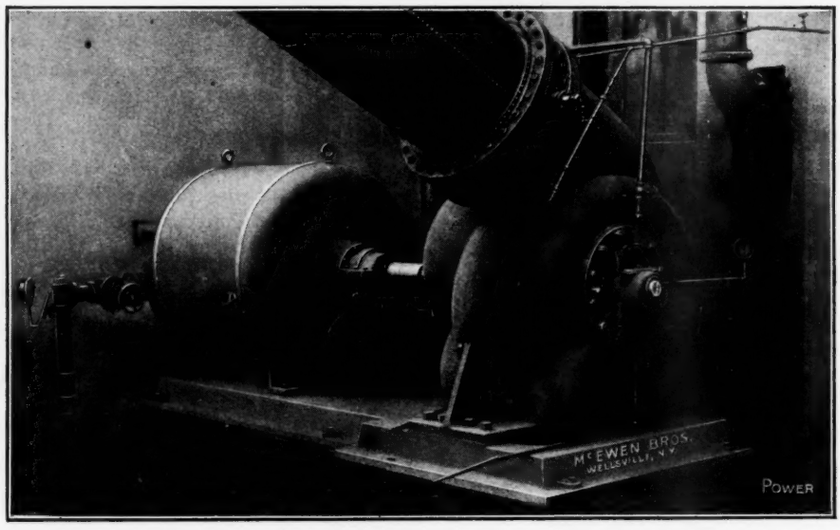


FIG. 6. SHOWING COMPACTNESS OF THE UNIT

This pump is made by the McEwen Bros., Wellsville, N. Y.

Lathe-Bed Pipe Threading Machine

The requirement of the average user of pipe-threading machinery is a machine that will cut off and thread pipes and thread nipples without the use of a nipple chuck. The Loew-Victor lathe-bed machine has been designed to do this work.

It has the revolving die head which is self-locking and self-releasing. The machine has two changes of speed operated by a gear shift; no countershaft is required, and tight and loose pulleys are furnished on the machine itself with a belt shipper.

The cutoff attachment is where it can be seen at a glance, even when the largest-size pipe the machine will take is being handled. Any size of nipple can be cut and threaded.

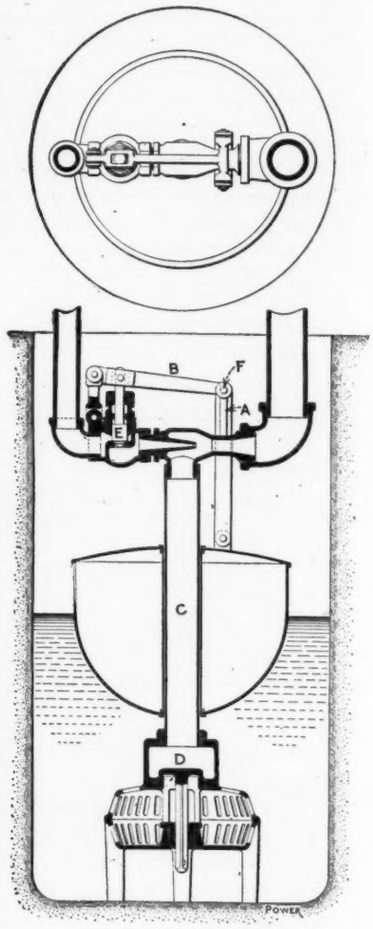
This machine is built for belt and motor drive by the Loew Manufacturing Co., Madison Ave. and Nickel Plate R.R., Cleveland, Ohio.

Automatic Pump Drainer

The Penberthy automatic ejector sump drainer, manufactured by the Penberthy Injector Co., Detroit, Mich., is operated by a jet of water controlled by a float and a quick opening and closing valve.

The float arm has a slot at *A* in which a pin in the valve-stem lever *B* slides. The float is compact, being made flat on top, and built around the suction pipe *C*, which is provided with a foot valve *D* inside the strainer. The valve is either wide open or completely closed, utilizing the actuating water to the best advantage. When the float has risen until the pin bottoms in the slot the valve *E* is then lifted from its seat by the float and the water pressure in the inlet pipe forces it fully open, shock being avoided by the cushion formed above the valve disk.

The valve remains open until the water in the sump lowers the float and the top of the slotted arm engages with the pin *F*. Any further drop of the float forces the valve downward and the suction through the valve draws the valve to its seat without shock, due to the partial vacuum in the chamber above the valve disk.



AUTOMATIC SUMP DRAINER

New Rice & Sargent Engine Governor and Stop Motion

These have been recently brought out by the Providence Engineering Works, Providence, R. I. The governor has two segmental weights with a spiral spring in tension connecting directly between them. The weights are mounted with roller bearings on bell cranks, which latter are connected to the usual sliding sleeve-and-collar arrangement. The center of gravity of each weight is in line with its bearings, and an arm on the

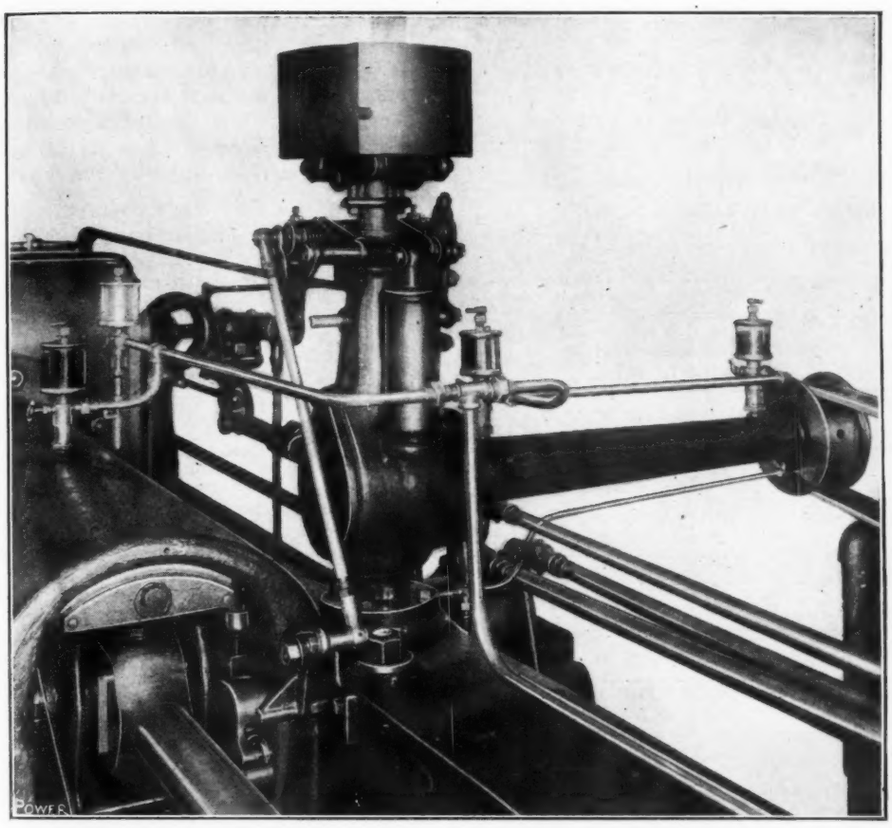


FIG. 1. GENERAL ARRANGEMENT OF GOVERNOR AND LATCH COUPLING

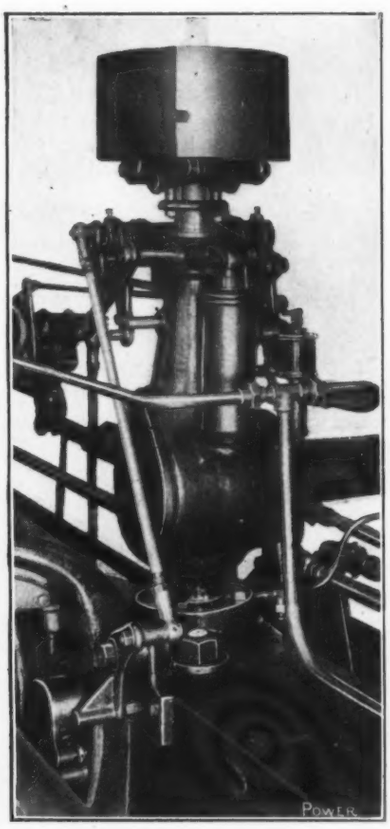


FIG. 2. LATCH RELEASED

weight is guided by the other weight, so that the two weights are kept in the same plane. The spring is easily adjustable for stability and change of speed.

The stop motion is operated by an inertia weight carried by the engine crosshead. Normally, this weight is held back against a stop by an adjustable spring, and remains quiet in relation to the crosshead; but when the engine exceeds a certain speed, the inertia of the weight overcomes the spring at the end of the engine stroke, so that the weight moves forward from the crosshead about ¾ in. and strikes a hammer blow against a lever pivoted to the bedplate, thereby releasing a latch and allowing the valve-gear to be moved up by a spring to the zero cutoff position, corresponding to the highest travel of the governor.

FIG. 3. WEIGHT AND BRACKET

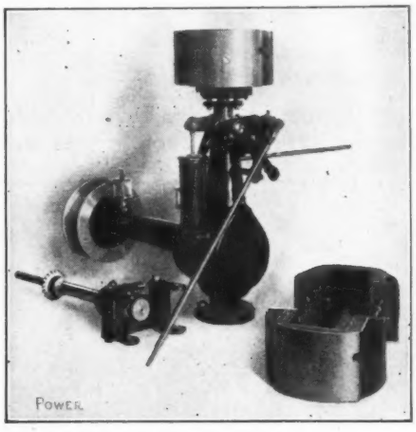


FIG. 4. PARTS OF GOVERNOR

Fig. 1 shows the general arrangement of the governor and also the position of the latch coupled up, ready for running.

Fig. 2 shows the latch released after the stop motion has operated and the levers connecting to the valve-gear moved up to the zero cutoff position. Fig. 3 shows the weight and its bracket, which is bolted to the crosshead. Fig. 4 also shows the latch released, and some of the main parts in detail. These levers may be drawn back and latched in again at any time when the engine is below the speed limit.

This stop motion does not require any attention when shutting down the engine or starting up, and the full movement of the governor weights is available for useful work. The stop may be tested at any time when the load is off the engine by pulling down on the levers to speed the engine up to the limit, which is usually 5 to 10 per cent. above the normal speed of the engine.

Where it is desired to use push-buttons for stopping the engine from distant points, a separate electrical arrangement is used whereby a weight is released to fall and strike a blow on the latch mechanism to release it. This stop motion is also used in connection with the throttle valve to release a latch or toggle and allow the valve to promptly close. In this case the stop weight is on the other end of the crosshead and operates at the head end of the stroke.

Calculating Horsepower by the Slide Rule

The next edition of George W. Richardson's instruction book upon the slide rule will contain the following directions for calculating engine sizes, speeds, horsepower, etc.:

EXAMPLE—Find the cylinder diameter of an engine to develop 154 hp. with a piston speed of 600 ft. per minute, and a mean effective pressure of 42 lb. per square inch.

First—Set 154 hp. on the right half of the "A" scale adjacent to 6 (600 ft. per minute) on the left half of the "B" scale, Fig. 1, with the hair line of the runner set to 33 (33,000 ft.-lb.) on the left half of the "B" scale as shown.

Second—Move the slide "B" to the left until 42 comes under the runner (Fig. 2) and adjacent to the special graduation mark "X" on the left end of

the "C" scale, read 16 in. on the "D" scale as the required cylinder diameter for such an engine.

Rule 1—To find the horsepower, set the special graduation mark "X" on the "C" scale to the cylinder diameter (16) on the "D" scale, Fig. 2, and place the runner to 42 (m.e.p.) on the "B" scale. Move the slide to the right (Fig. 1) until 33 on the "B" scale comes under the runner. Then read 154 hp. on the "A" scale over 6 (600 ft. piston speed) on the "B" scale.

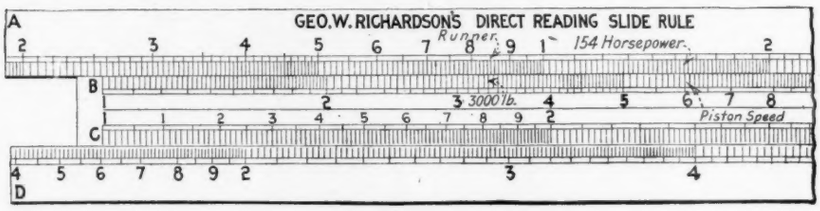


Fig. 1

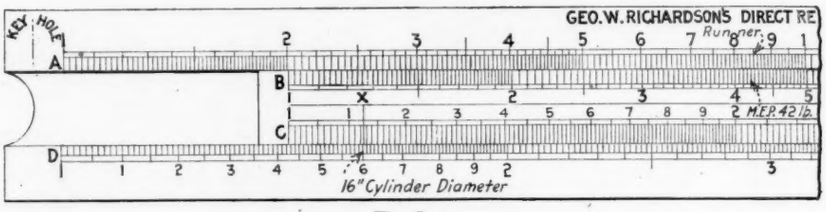


Fig. 2

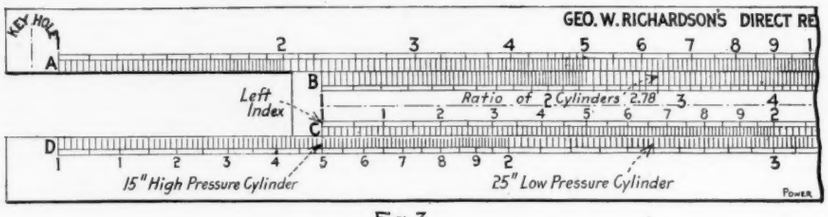


Fig. 3

OPERATIONS IN CALCULATING HORSEPOWER

Rule 2—To find the piston speed in feet per minute, proceed the same as in rule 1, except that the answer is read under 154 hp. on the "A" scale; read 600 ft. per minute on the "B" scale (Fig. 1).

Rule 3—To find the mean effective pressure of the same engine, set 154 hp. on the "A" scale, Fig. 1, against 6 (600 ft. per minute) on the "B" scale, and place the hair line of the runner to 33 (33,000 ft.-lb.) on the "B" scale, and leaving the runner at this point, move the slide until the special graduation mark "X" on the "C" scale is adjacent to 16 in. on the "D" scale, Fig. 2—and under the hair line of the runner on the "B" scale, read the answer 42 lb., mean effective pressure.

It will be noted with the setting as last explained, that if the slide "B" be moved back and forth, the mean effective pressure is increased or decreased, likewise the cylinder diameters are increased or decreased in the same proportion. The same ratio will be noted with a variation in piston speed; any increase or decrease in piston speed, the horsepower remaining the same, would require a corresponding increase or decrease of the mean effective pressure or cylinder diameter.

The calculation is simplified by putting a graduation mark at "X." In the example given

$$Hp. = \frac{Pressure \times area \times piston\ speed}{33{,}000}$$

$$154 = \frac{42 \times area \times 600}{33{,}000}$$

and

$$Area = \frac{154 \times 33{,}000}{42 \times 600}$$

The operation as outlined consists in dividing 154 by 42, then by 600 and multiplying by 33,000. With this setting the index of slide "B" would be opposite the required area on the "A" scale. This area is

$$A = D^2\,0.7854$$

then

$$D^2 = \frac{Area}{0.7854} = 1.273 \times area$$

The mark "X" is therefore put at 1.273 on the "B" scale and indicates by its position the square of the required diameter on the "A" scale and the diameter itself on the "D" scale. It is presumed that this special mark will be carried upon the "Richardson Rules" in the future.

RATIO OF COMPOUND CYLINDERS

EXAMPLE—Required to find the ratio of two cylinders 15x25 in. in diameter.

First—Set the left index on the "C" scale to 15 in. on the "D" scale. Next place the hair line of the runner to 25 on the "D" scale, and under the same line read 2.78 on the "B" scale (Fig. 3), which is the ratio of the two cylinders.

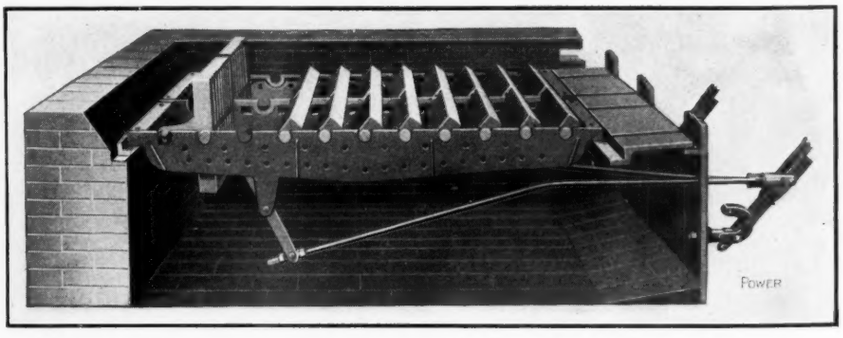
Suppose it is desired to have a triple-expansion engine with the high, intermediate and low-pressure cylinders having a ratio of 2.78.

First—Perform the preceding operation, which gives the high- and intermediate-pressure cylinders. Then move the left index of the "B" scale to the hair line of the runner and move the latter to 2.78 (the given ratio) on the "B" scale. The diameter of the low-pressure cylinder will be found under the hair line of the runner on the "D" scale, which is 41.5.

The cylinder sizes of a quadruple-expansion engine can be ascertained by extending the last operation in a similar manner.

Kelly Rocking and Dumping Grate

An improvement to the Kelly rocking and dumping grate, shown herewith, consists of a large rear dump grate which is operated independently of the main grate surface, and is for dumping the larger clinker formation at a point which ordinarily receives the least attention.



IMPROVED ROCKING AND DUMPING GRATE

The fuel bed is broken up by the movement of the grate, and the rocking motion tends to shift the fuel toward the rear of the furnace. This grate is self-contained and its installation does not require any alterations in the ordinary furnace. It is the product of the Kelly Foundry & Machine Co., Goshen, Ind.

Readers with Something to Say

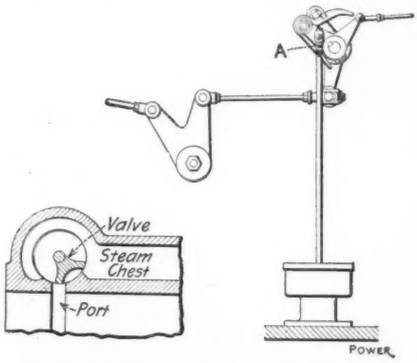
A letter good enough to print will be paid for. Ideas, not mere words, wanted

Corliss Engine Troubles

A 16x36-in. single-cylinder, double-eccentric, noncondensing Corliss engine is fitted with double-seated steam valves working over a single port passing steam under the two faces of the valve and over the two edges of the single port, as shown in the illustration.

In looking over some back numbers of POWER I read about setting the valves on double-eccentric Corliss engines with negative steam lap and the main eccentric set back to get proper lead, thus getting a late cutoff adjustment up to seven-eighths stroke.

Wishing to be uptodate, I tried to get this adjustment on my Corliss, but after making the eccentric changes and shortening the steam-valve rods, I found that it was impossible to shorten them for negative lap or even line-and-line without the valve-stem crank rising high enough to cause the dashpot rod to strike the valve crank as shown at *A*. I had to put my valves back to about one-half cutoff.



DOUBLE SEATED VALVE AND CORLISS VALVE GEAR

This engine has run away three times within a year, the first accident being due to the ball-bearing cone coming unscrewed in the governor, forcing the governor rods to a position for a later cutoff until the governor weight had reached the limit of travel, and when the load dropped the engine speeded up. As I was handy to the throttle, the local junk dealer suffered a great loss in the profits derived from old junk. The other two runaways were caused by the main shaft collar which carried the governor belt coming loose on the shaft, but still having enough friction to rotate the governor.

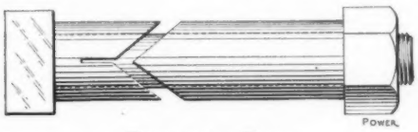
We did not shut down in either case, but pulled the load by blocking the governor and throttling the engine, which requires some maneuvering to run a generator smoothly.

E. C. SUTTON.

Estherville, Iowa.

Emergency Expansion Bolt

It sometimes happens that an engineer will require an expansion bolt, but on account of isolation or other unfortunate conditions, he cannot obtain it. Under such conditions, an expansion bolt may be made of two pieces of pipe cut as shown in the illustration. The pipes are then slipped over an ordinary bolt. Little time or expense is required to make it and it will serve for ordinary conditions.



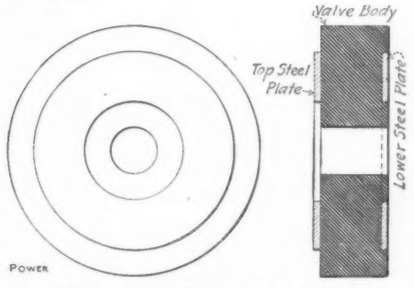
EXPANSION BOLT

J. DALY.

Brooklyn, N. Y.

Soft Valves and Hot Water

Some time after making an addition to our plant it became necessary to run the boiler-feed pump under widely varying pressures and feed-water temperatures. During the day the pressure and water temperature were considerably lower than at night.



REINFORCED PUMP VALVE DISK

Previous to the change in pumping conditions, soft flexible valves were used in the pumps with good results. Under the new conditions these valves would cut through between the ribs of the valve seats. As a relief for the trouble, metal and hard composition valves were tried, but with little success on account of the water containing much gritty matter; this required frequent regrinding of the valves and seats.

Then the following valve arrangement was tried with satisfactory results, and also admitted of using the soft valves: An annular space slightly less than the outside diameters of the rim and hub of the valve seat was cut out of both sides of the valves, as shown in the illustration. Two $\frac{1}{16}$-in. steel plates were used to reinforce the valve, one fitting on each side, as shown; countersunk rivets secured the plates. As these plates took all the pressure, the life of the valves was considerably lengthened; they also seat well, thus enabling the pumps to run at a very slow speed without slippage or noise.

D. H. HULL.

Asylum, Miss.

Influence of Speed on Cylinder Condensation

I do not find any definite or satisfactory information with regard to the influence of speed on cylinder condensation. Which has the greater effect, piston speed or rotary speed?

Which engine, for instance, will show the larger percentage of initial condensation, a 24x48-in. running at 80 r.p.m. or a 24x24-in. running at 160 r.p.m.? I should like to have the opinions of your correspondents backed up by reasons and test results.

B. T. ABBOTT.

Chelsea, Mass.

Failure of Boiler Tubes

One of the most serious troubles with water-tube boilers is the failure of the tubes. Is this due to tubes of inferior quality or to other causes? I have always noticed that in boilers of this type, whether horizontal or vertical, the tubes fail in a line with the baffle arch. After increasing the distance between the tubes and the arch I have lessened this trouble, but when this distance is increased from 15 or 18 in. to 28 in., is there not a loss in efficiency?

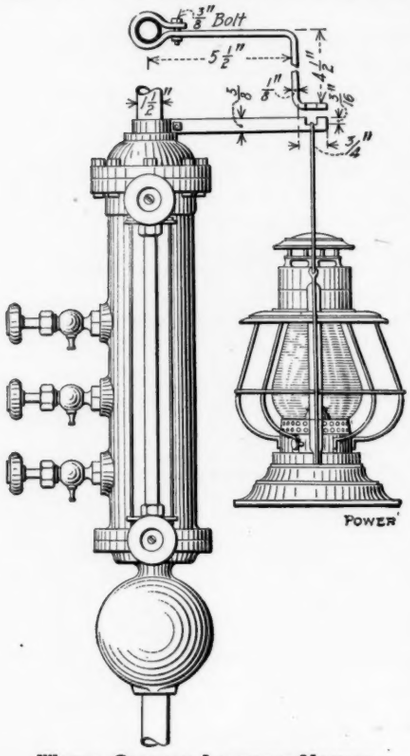
The bagging of tubes is oftentimes due to an accumulation of scale, oil or dirt at the ruptured part, but where an arch is built closely to the tubes it seems that bagging sometimes occurs when they are perfectly clean or when the amount of scale is so small that it alone is not the direct cause of rupture. Besides, the tubes sometimes break or leak badly at the tube sheet or header. What causes this?

W. J. MAXWELL.

Indianapolis, Ind.

Lantern Hanger

To make it convenient for the watchman to see from a distance the water level in the boilers, I made a lantern hanger, shown in the illustration, of mild steel. The loop around the pipe was bent on a separate piece of 1½-in.



WATER COLUMN LANTERN HANGER

pipe. The rest was bent as shown. When it was to be placed on the pipe of the water-column it was sprung open at the end of the loop and slipped over the pipe; then the ⅜-in. bolt was fitted and tightened.

FREDERICK L. JOHNSON.

Paterson, N. J.

Repairing a Blown Out Gasket

A portion of the gasket blew out in the inner head of one of our air-compressor cylinders, and we had to stop the leak without renewing the gasket, which would take from 24 to 30 hours and cause a shutdown of the whole plant.

After closing down for the day I made a paste of some iron cement and tamped it in the joint where the gasket blew out. A portion of the iron cement was then put on a block of wood which had previously been cut out to conform to the outline of the cylinder; the block was then securely bound to the cylinder by means of band iron drawn together with screws. The compressor was ready to operate the next morning and the leak had been effectually sealed; after running for several days, the block was removed.

The compressor has been running continuously for several weeks at 100 lb. pressure and the joint is still tight.

E. B. ANDERSON.

Rochester, N. Y.

Numerous Repairs

I had a plant to overhaul where everything had been left undrained the winter before, and it is needless to say that everything which could burst did so, especially the pumps. A duplex boiler-feed pump having burst in the suction nozzle, I repaired it by drilling a 1/16-in. hole all the way through the broken piece and the wall that was intact. Then I cleaned the edges with muriatic acid and water and applied iron cement, pulling the edges together with 1/16-in. bolts passing through the nozzle. This pump has had eight months' service without a leak.

Another pump had a snap piston ring broken. I needed one of 4 in. diameter to replace it, but could only find old rings that were 5 in. in diameter, one of which I made to fit by drawing it down to the required size. All that was necessary was to cut off the excess ends and file down one side until it fit the groove in the piston.

At another place I had to retube a horizontal return-tubular boiler. After knocking the old tubes out I found the shell and the heads in fair condition, except at one place at the top of the rear tube sheet the fusible plug had leaked, causing corrosion, and almost eating away a place about 1½ in. in diameter. As I was unable to get a boiler maker, I had to make this repair myself. I obtained a ¼-in. patch large enough to cover the defective area and riveted it on inside of the tube sheet, using red-lead putty between the patch and the sheet. I used six ⅜-in. rivets, which made a fair job, and they will last as long as the boiler, about two or three years, because of bad water and lack of proper attention. I reduced the pressure on this boiler from 100 lb. to 80 lb. gage.

This same plant had a deep-well steam pump that had frozen and broken the steam piston. I repaired this for temporary use until a new one could be obtained by countersinking holes in the top head and threading holes in the bottom head and using three ¼-in. bolts with countersunk heads to hold the heads together. Iron cement was used between the broken ends. This repair has been running nearly three years without using the new piston.

I have tried rivets instead of bolts to make a repair like this, but find that I cannot pull the heads together evenly with the rivets.

D. W. SCARBOROUGH.

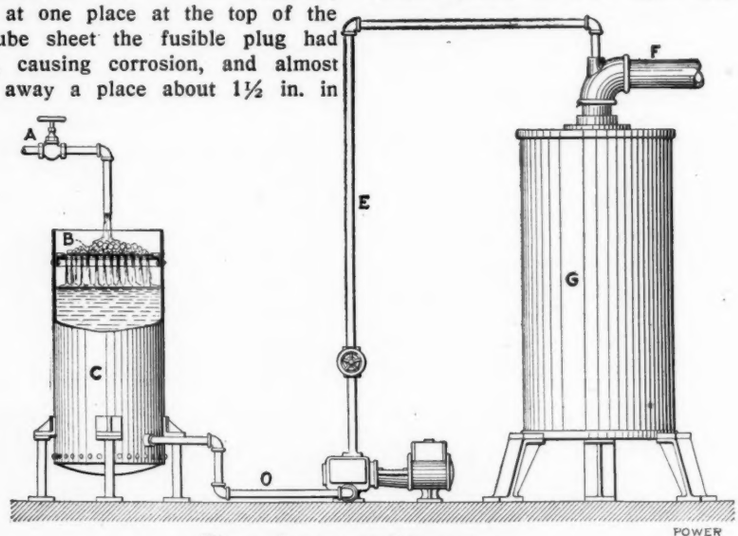
Richmond, Tex.

Treating Feed Water

In our plant we are treating the feed water with barium hydrate. River water is used in the boilers, and we take it directly from the condenser hotwell and pump it into the heater.

In treating the water we first dissolve the barium hydrate in a tank, the salt readily dissolving and a small single-acting plunger pump forcing the solution into the feed-water pipe leading to the heater. The pump is run at a constant speed so that there is a constant injection of the solution.

We tried soda ash but found that it made a hard scale on the tubes. The barium hydrate is much better and effectively clears muddy water. Soda ash, if used too freely, is liable to cause foaming of the boilers. The quantity used is at the rate of 1 lb. to 2000 gal. of water. The sketch shows the method of using the solution. The barium hydrate is placed on the screen *B* and a small stream of hot water from the pipe plays on the lumps, dissolving and carrying them into the tank *C*. The solution is then drawn through the suction pipe *O* into the pump and discharged through a ½-in. pipe *E* into the water inlet pipe *F* and then into the heater *G*.



WATER PURIFYING EQUIPMENT

A. RAUCH.

Pittsburg, Penn.

Difficult Test Conditions

I recently had an experience which might not have been a problem for many engineers, but it kept me studying for several days before I hit upon an easy solution. I was asked to pass judgment on a second-hand boiler and wished to subject it to a hydraulic test, but a careful search throughout the town failed to reveal a pump that could be used to obtain the necessary pressure. Confident that I could devise some means to accomplish my purpose, I went forward with the work of inspecting the boiler and getting it ready for the test.

After blocking the boiler up so that the place where the gage was to be connected would be the highest, I filled the boiler with water until it ran out of the pipe on which the gage was to be screwed. The purpose was to drive out all the air possible. As the boiler was of the locomotive type and lay on its side there was probably a little air left in the dome. After screwing on the gage and closing every outlet tightly, I built a fire of light wood in the firebox and the expansion of the water quickly gave the desired pressure. A globe valve was provided to let out the water as soon as the right pressure was reached and the gage was watched carefully as the pressure rose rapidly when the water began to get warm.

In small towns it is especially necessary for an engineer to be resourceful and the genius often displayed by country engineers would greatly tax the ability of their better-paid brothers of the city.

G. E. MILES.

La Jara, Colo.

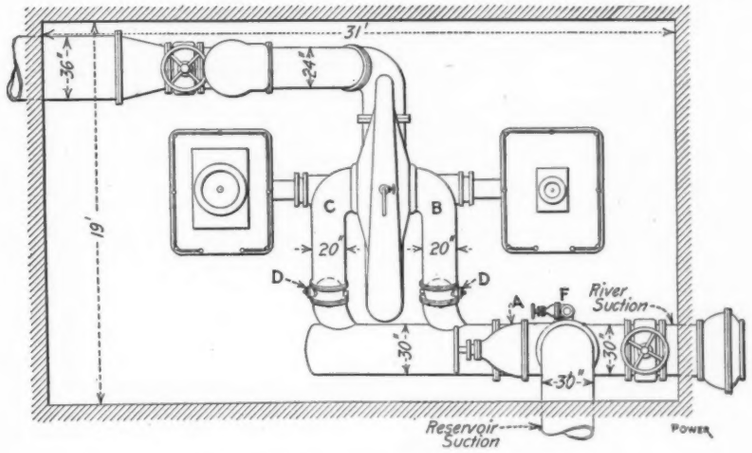
Centrifugal Pump Installation

The accompanying illustration shows the arrangement of a 25,000,000-gal. centrifugal pump direct-connected to a 14 and 30 by 24-in. cross-compound vertical Corliss engine. The suction and discharge pipes are so laid out that water may be pumped from the river to the settling basins, or from the basins to the high-pressure station located quite a distance from this plant.

In order that the pump may raise water from the river when it is at its lowest recorded level, it was placed at an elevation of 19 ft. above that level. As the highest recorded level is 29 ft. above the lowest, it was necessary in protecting the pump from being flooded, to construct a concrete wall entirely around it.

The conditions required that the pump be placed at right-angles to the suction and discharge pipes, and use a P double suction instead of the common Y-arrangement. The main suction was reduced to 30 in. and each run of the double suction to 20 in, with a 24-in. discharge. Usually the sizes are 36, 24 and 30 in., respectively. Butterfly valves *D* were fitted in each of the double suction pipes to equalize any unbalanced shaft thrust that would be caused by the uneven flow of water into the double suction pipes. It has not yet been found necessary to adjust these valves.

In the winter, when ice clogs up the screens at the intake, much air is taken into the pump with the water. Under such conditions, with a suction lift of 18 ft. at *A*, *B* will show 18 ft. and *C* 21.5 ft., depending upon the amount of air passing to *B* and partly destroying the vacuum.



ARRANGEMENT OF PUMP ENGINES AND PIPING

When the river is at its low level it is frequently impossible to obtain the suction by priming by means of the bypass valve *F*, but by partly opening the main valve and starting the engine, suction is readily obtained. The reason for this is that the water supplied from the reservoir is insufficient for the speed of the pump and a vacuum is created in the suction which raises the check valve and allows air to enter.

LAWRENCE KJERULFF.

Kansas City, Mo.

Simple Valve Wrench

The accompanying illustration shows a simple valve wrench which may be made from an old file. Besides being used for opening and closing stubborn valves, it serves well to push packing into a stuffing-box.

VALVE WRENCH MADE FROM A FILE

The amount of taper given to the wrench should be from 1 to ¼ in. for ordinary work. To work it, the wrench is inserted between the spokes of the valve wheel edgways.

J. S. ALLEN.

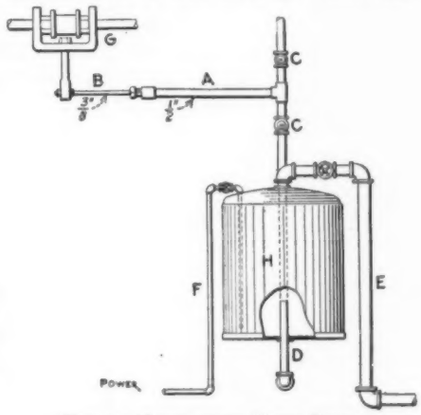
Santa Barbara, Calif.

Boiler Compound Feeder

The usual methods of feeding boiler compounds to the boilers are generally productive of poor results on account of the difficulty of maintaining the proper proportion of the compound to the water evaporated.

To obtain this condition and maintain it automatically we use the apparatus shown in the accompanying illustration.

The pump *A* is made of ½-in. pipe and fittings and a brass stuffing-box drilled to take the ⅜-in. plunger *B*. Two ½-in. check valves are placed at *C* on the suction and discharge pipes. The suction enters the bottom of the compound tank *H*, extending for about 6 in. into it as shown at *D*. A ¼-in. steam line containing a valve *F* runs over and into the tank for the purpose of agitating the fluid. There is also a ¾-in. water-supply line *E* to which are attached a valve and float, not shown in the illustration; the level of the fluid is thus automatically maintained.



BOILER COMPOUND FEED PUMP

The required amount of compound is placed in the tank every six hours. As the fluid pump is operated by the crosshead *G* of the boiler-feed pump and discharges into the suction of the latter, the right quantity of compound is always fed to the boilers.

Tipton, Calif. B. F. HARTLEY.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Should an Engineer Purchase Instruments?

Of course the question as to how much an engineer should spend for instruments used in power-plant practice will long remain an open one because it is a matter of personal opinion influenced by the size of the individual's pocketbook.

However, the man purchasing an indicator, Orsat and other apparatus is usually well compensated. The experience gained by their use not only better fits a man for conducting his own plant economically, but he might possibly make some money in doing test work on a small scale. His only requirement is the time necessary to do the work.

J. C. HAWKINS.

Hyattsville, Md.

Two Kinds of Avoidable Explosions

Here is an instance of a third kind of avoidable explosion that may be interesting in connection with the editorial under the above heading in the Apr. 23 issue: Two engineers, in different parts of Sandusky County, attempted to clean soot from the tubes of upright boilers by throwing a pound of gunpowder in the firebox. The report as to the efficiency of this method is incomplete. The tubes remained, but the men went into the hands of physicians for repairs and treatment.

E. STANLEY THOMAS.

Fremont, Ohio.

What Causes the Sediment

Referring to W. V. King's inquiry in the Apr. 30 issue, I would infer that the water used contains ferrous salts in solution. This can be tested by dissolving a little potassium ferricyanide (K_3FeCN_6) in distilled water, and adding some of the suspected water to it. A blue precipitate shows ferrous salts in the surface water.

If this reaction proves the presence of ferrous iron, it can be taken out by treatment in open tanks with either lime or soda, or even better, if the amount is small so that the expense is not prohibitive, by sodium peroxide; 1 gr. of sodium peroxide is equivalent to 5.8 gr. of ferrous sulphate or 2.1 gr. of metallic iron.

DONALD M. LIDDELL.

Elizabeth, N. J.

Soda for Cleaning Lubricators

The many lubricator experiences related in past issues call to mind a method I use to improve the feeding of the oil. When the feed is not steady and there is an accumulation of oil in the sight-feed glass, the use of soda will correct the trouble. I put in a pinch of soda and allow it to settle to the bottom of the glass.

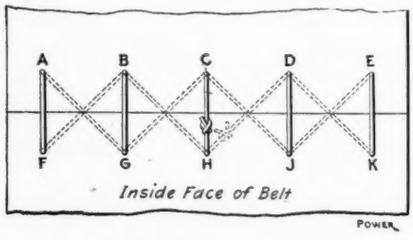
JOHN YOUNG.

Utica, N. Y.

Belt Lacing

In the issue of Apr. 16, Mr. Fries has written a very interesting letter about wire lacing and my experience confirms all that he has said in favor of it. I have found, however, that the method described by him has a tendency to throw the end of the belt out of line, particularly when the belt is subjected to sudden strain. To overcome this, many engineers use a form of lacing that makes the lateral stress equal in each direction, and the joint is strong and very satisfactory under the most severe conditions.

To lace a belt in this manner, use a



SHOWING METHOD OF LACING

piece of lacing wire whose length is about ten times the width of the belt, and locate the middle point of the wire. With the end of the belt squared and the holes marked, begin by drawing the wire up through *C*, as shown in the illustration, and down through *H*, pulling the wire until the middle point is between *C* and *H*; then carry the end of the upper section of the wire up through *G*, down *B*, up *F*, down *A*, up *F* again, down *A* again, up *G*, down *B* and up *H*. This will complete one-half of the joint. With the other end follow the same plan in holes *D*, *E*, *J* and *K*, thus completing the second half of the operation. The two ends will now be at holes *C* and *H* of the outside face of the belt. They should be twisted together and pounded into the leather with the rest of the lacing.

To those who have never made a wire joint, I would say that after the ends of the belt are squared, a line should be drawn parallel to the end edge and about $\frac{1}{16}$ in. more than the thickness of the belt back from the edge. Such a line would join *A* and *E* of the illustration. The holes should be marked off on the line with a pencil; the ends of the wire may be filed to a point to facilitate their entrance into the hole. It is better to make the holes as they are needed rather than make all of them before starting because the holes will close up some as the belt is handled, thus making it difficult to push the ends of the wire through the holes. A handy awl may be made by taking a 4-in. piece of round steel wire tempered and ground to a point and inserting it in a handle.

A wire-laced joint is not as good as a cemented one, but it has these advantages: it can be made quickly, and when made properly it will run as smooth as any part of the belt.

W. G. HAWLEY.

Clark's Summit, Penn.

Chimney for Dissipating Smoke

A newly patented chimney for dissipating smoke was described by Dr. Alfred Gradenwitz in the Apr. 2 issue; it seems to me nothing more than a clever contrivance to outwit the smoke inspector.

The chief damage from smoke is the minute particles of carbon which settle over the surrounding territory. If an ordinary chimney scatters this carbon for a mile and the dissipator scatters it twice as far, it would be a good thing for the people near the plant and a poor thing for the residence property further away. In a city with a chimney every half mile or so apart, what will be the result?

We have a smoke dissipator in our plant, but never had it patented. Our smoke inspector is rather strict, and as we have a few barrels of sawdust to dispose of every day and it creates much smoke, we got a notice from the smoke inspector. Since then we have dissipated the smoke by burning it after dark with very good results—to our company.

JOHN BAILEY.

Milwaukee, Wis.

Barometric Condenser in Turbine Practice

In the description of the pumping plant at the Sloss Iron Mines in the Apr. 9 number the turbine is shown connected to a barometric condenser and the exhaust pipe has a drop leg in it where it comes from the under side of the turbine and runs horizontally to the riser in the condenser.

In the above installation I have no doubt that this is properly drained, but I once operated two turbines with the same arrangement which ran on widely varying loads.

On the bottom of the horizontal pipe there were two 2-in. outlets with a gate valve and swing check valve connected to each. When warming the turbine all of the condensation ran out by gravity before the condenser was thrown into operation and when the vacuum began to rise the check valves closed automatically and were kept closed by the atmospheric pressure; in the same way, when the turbine was stopped, they opened again.

As will be seen, these drips were useless when there was a vacuum existing in the exhaust pipe, so that if a large quantity of water flowed in, the drips did not protect the machine.

It was necessary to run one of the turbines continuously, and on days when but little power load was needed, the load dropped as low as 50 kw. Under a 28-in. vacuum the exhaust pipe became quite cool almost up to the turbine, and what little steam was flowing through condensed and left the water in the drop leg. Here it accumulated until the pipe was nearly full, when a slight clicking was heard in the riser which increased as the amount of water increased. Then it was necessary to break the vacuum when the check valves opened and allowed the water to run out. This caused two serious accidents in this plant, one when the exhaust pipe was cracked and one when the water surged back into the turbine wheels and tore out a large number of the blades. Thereafter, the operators looked out for the trouble and checked it in time to avoid any accidents, but if they waited too long there was a heavy rumbling noise and water flew out at the relief valve. During heavy loads no trouble was experienced as there was steam enough flowing to prevent any condensation in the exhaust pipe.

This form of condenser is the only one where the piping should have a drop leg or pocket where water can accumulate; with the surface or jet type the turbine can be located above the condenser and all condensation will flow into it.

In this instance, the chief engineer tried to have an apparatus installed which would take care of the water at any time. All such exhaust pipes, whether they are on an engine or turbine, should be fitted with a vacuum trap which automatically admits steam and discharges the water as fast as it accumulates. Such a trap in the plant mentioned would have well paid for itself.

G. H. KIMBALL.

East Dedham, Mass.

Asbestos Drum Covering

Mr. Koppel's letter under the above title in the Apr. 9 issue brings to mind a similar experience I had in covering the bottom of a receiver with asbestos. I did not think of the method Mr. Koppel used, but I finally succeeded in making the asbestos stick to the receiver.

After about two hours of hard work and nothing accomplished, I decided to try applying ordinary red clay, mixing it with water to the consistency of house paint and using a brush to apply it. It proved successful as the receiver was hot and the clay dried quickly. After giving the receiver two coats of clay, the asbestos was put on with a trowel.

J. W. DICKSON.

Memphis, Tenn.

Water Gage Illuminator

While I agree with Mr. Dixon's comment under the above heading in the Apr. 2 issue, that the use of a mirror behind a water gage-glass is not to be recommended, I do not agree with some of his other statements.

Mr. Dixon should remember that a glass does not always remain clean, and that the reading of the water level is thereby made difficult as the glass becomes more cloudy. To facilitate the reading under such conditions I use a white strip of paper mounted on a board which is hung back of the glass; an electric light is also hung near the glass, and is protected from breakage in case the gage-glass is blown out.

WILLIAM E. DIX.

Los Angeles, Calif.

Benefits of Mutual Aid

Too much prominence cannot be given the thought expressed in the foreword in the issue of Apr. 2, "A man cannot turn anything over in his mind unless he knows it."

The policy adopted by a great many chief engineers, foremen and master mechanics, of keeping down and neglecting to instruct the men under them, is absolutely criminal and should be condemned in the strongest terms. I have often heard foremen complain that they were not going to tell the men under them everything they knew, and make them capable of taking their jobs.

This shows how narrow-minded some men are. By instructing their assistants properly, they would make their own work lighter and easier. They would be accomplishing some good in the world other than working just to live, and would advance to a certain extent the engineering knowledge. So give the cubs a chance, help them all you can; we were all cubs once, and no doubt all of us appreciate a helpful word. The cubs of today will be the leaders of tomorrow.

A. RAUCH.

Pittsburg, Penn.

Cold Air and Leaky Pipe Joints

I do not agree with some of L. J. Ollirer's statements in the Apr. 2 issue. If steam pipes are properly installed and allowance is made for expansion and contraction, the joints should not leak even if exposed to severe cold air currents. In many plants steam is turned on and off the lines frequently and the resultant contraction and expansion cause no leaks.

If the flanges are brought in line with each other and are free from pits and dirt, and a good grade of packing is used, there is no reason for leaks due to cold air currents striking the piping. Any joint not properly put up will leak in time.

JOHN THORN.

London Junction, Ont.

I am sure cold air causes leaky joints. In our plant we have a steam turbine, and from where the main steam line connects on the separator to the wheel case there are eight flanged joints. If the windows are left open in cold weather the joints begin leaking and will continue to do so until the windows are closed. A good grade of packing is used.

W. N. BEHEN.

Bilington, W. Va.

Pump Would Not Force Water

In regard to J. W. Dickson's letter in the Apr. 23 issue as to why the raising of the suction pipe caused the water to flow, there seems to be but one good reason.

Probably if the suction strainer had been examined in the first place it would have been found to be imbedded in the mud. Raising the pipe 4 in. lifted it out of the mud and allowed the water to flow.

It is possible, too, that the elbow directly below the pump leaked air, and by raising the pipe line the threads were tightened and the leak stopped. The admission of air at that point would, of course, break the suction.

There seems to be no other reason for the pump's failure; in fact, the new position of the suction pipe apparently

precludes successful operation, as there is an excellent opportunity for the formation of an air pocket in the suction line. A glance at Mr. Dickson's sketch will make this evident.

GRANDON D. GATES.

Seneca Falls, N. Y.

Value of a CO_2 Recorder

Judging from Mr. Franklin's comment, in the Apr. 16 issue, under the above heading, on my letter in the Feb. 13 issue, he apparently belives that I am not in favor of flue-gas analysis, he probably has this impression because I failed to clearly express myself.

While I consider flue-gas analysis necessary to the efficient management of a plant, I also contend that it is a mistake to set too high a standard and hold the firemen to it. It is better to keep from the men the fact that there was a standard; they would then have no reason to cheat. The engineer would then be able to discover and remedy faults in boiler settings and furnace construction, have a check on the fireman, be able to instruct him when necessary, and so gradually bring the men and the plant up to real efficiency.

By setting too high a standard and saying, "It's this or your job," the men are given a motive to cheat, as then the job is of greatest importance. On the other hand, by setting too low a standard, the average fireman will think that when he has attained it he has done enough, and will make no effort to do better. A faked sample is worse than no sample at all.

I agree with Mr. Franklin that 16 per cent. of CO_2 is unusually high, but we got it where one of the boilers was in a battery, and the partial closing of the damper necessary to get a high percentage did not materially affect the total output of steam. Also, one man gave his whole attention to that boiler, and tried to get the highest possible CO_2. These conditions are absent in everyday practice, and I would not stake anything on getting 16 per cent. from this boiler under everyday conditions. If the dampers on an entire battery are only slightly hauled, it would cause a drop in the steam pressure. The fireman in the average plant also has his boilers and boiler room to keep clean, and has to assist the engineer at times; he cannot give his boilers the attention necessary to get as high a percentage as 16.

The percentage of CO_2 in small boilers is apt to be lower than in large ones because the smaller fire requires more frequent attention than the larger one, and frequent opening of firedoors admits an excessive amount of air.

In a coal-burning plant with average firemen, 10 per cent. CO_2 is a good average. I have averaged 12 per cent., but it required my entire attention in the fireroom watching the men and "jockeying" the dampers, besides keeping an eye on the stack for smoke.

I cannot tell Mr. Franklin why 11.5 per cent. was used as a standard; I was told to obtain it. Personally I consider it a little too high. In the plant discussed an analysis of the flue gases is made at the end of each watch, and sampling bottles are used instead of a recorder.

A. POHLMAN.

Brooklyn, N. Y.

Wavy Expansion Line

J. W. Dickson's letter and illustrations under the above heading in the Apr. 16 issue are very interesting.

Referring to Fig. 5, I think the pipes from the angle valves to the three-way cock are too large, as they form a condensing chamber, and when the valves are opened the clearance space is increased considerably. The nipples attached to the cylinder at the clearance space cannot be greater than the usual ½-in. size; therefore I should have continued the ½-in. pipe to the three-way cock.

It appears that a light load was being carried when diagram Fig. 3 was taken, but either a higher steam pressure or a lighter load would make a difference in the expansion line. I believe that condensation in the 1½-in. pipe was the cause of the wavy expansion line in Fig. 2. It has also been my experience that long indicator piping has a tendency to conceal defects rather than disclose them; therefore the connection should be as short as possible to obtain a true diagram.

LEIGHTON JOHNSON.

Exeter, N. H.

The Three Pressure Problems

Answering Mr. Hawkins' pressure problems in the Mar. 26 issue, I submit the following:

1. There is water inside of the spring of a steam gage, and when the gage is first applied to the boiler the spring is of course full of air at atmospheric pressure. On the pressure being raised in the boiler this air is compressed into a small volume, the volume depending upon the pressure in the boiler. In time this air will be absorbed by the water formed in the siphon, to which the gage is attached.

2. The gage will show the same pressure as that on the boiler. I know of such an installation in which there are 200 ft. of ¼-in. pipe between the gages, and the distant gage indicates the pressure accurately.

3. The friction in the pipe would not affect the pump so that no water would be discharged. Friction depends upon the velocity of the water as well as the length of the pipe, and the effect of lengthening the discharge pipe would be to increase the head on the pump and thus reduce its speed and capacity. To prevent any discharge, the static head must be increased so that the pressure on the plungers will balance the pressure on the pistons.

If lengthening the horizontal run of discharge pipe in this case would prevent the discharge of the pump, the distant gage of question No. 2 would show a reduced pressure.

C. O. SANDSTROM.

Kansas City, Mo.

1. If the gage is connected with a coil or siphon between it and the boiler, as most gages are, the spring is filled with air. Water condenses and collects in the coil, forming a water seal which keeps the steam out of the gage. The air in the gage will maintain a lower temperature than the steam, thereby lengthening the life of the gage.

2. The gage on the boiler and the one at the end of the pipe should show the same pressure. This is true only when there is no flow in the pipe from leaks or steam being taken off by branch lines.

3. No matter how long the pipe is, there will be a flow of water through it so long as the total lift remains constant. The friction losses in the pipe and at the discharge can be expressed by the formula

$$f = m\frac{22}{g}$$

where

f = Loss due to friction (feet head);
m = Constant depending upon size of the pipe;
v = Velocity of the water
g = 32.2 (acceleration due to gravity).

By making v very small, f is small, so that the head pumped against is really only a little over 10 ft. The velocity will automatically adjust itself to the friction head and the head due to the 10-ft. lift and the pressure produced by the pump.

EARL S. RUSH.

Lawrence, Kan.

Water Tank Gage

Edward L. Johnson's water-tank gage, described in the Apr. 23 issue, could be improved by attaching a bell circuit with contacts on the indicator at the high- and low-water limits, with one wire connected to the rack and a small switch placed in the line.

A more convenient and less expensive method would be to install an altitude gage in the discharge line to the tank above the pump as it practically takes up no space and is more reliable. With a pump-controlling valve to control the action of the pump by the change in the discharge pressure, he would have a thoroughly automatic arrangement.

JAMES G. SHERIDAN.

Brooklyn, N. Y.

Inquiries of General Interest

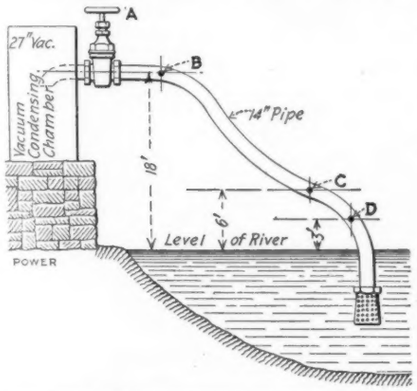
Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Pressure at Different Points Along a Pipe

What will a vacuum gage register when connected successively at points *B, C* and *D* of a pipe connected as in Fig. 1, the points for gage connection being respectively 18, 6 and 3 ft. above the level of the water of the river from which the supply is drawn, the injection valve *A* being wide open and the pipe connected to the condensing chamber in which a 27-in. vacuum is maintained, shown by the diagram?

W. J. H.

Neglecting the small siphoning effect due to turning down the end of the pipe



PRESSURE AT DIFFERENT POINTS ALONG A PIPE

after it has entered the condensing chamber, the variable density of the water while flowing through the pipe (due to liberation of air) and the very small difference of gage reading that would result from attaching the gage above or below the center of the pipe, the pressure indicated by the gage placed at *B* would be the same as the pressure in the condensing chamber, 27 in. vacuum.

Placed at *C*, the gage would indicate the same pressure as at *B* less the downward pressure per square inch, which would be due to a column of water having a head equal to the difference of elevation of the points *B* and *C;* that is,

$$18 - 6 = 12 \textit{ ft.}$$

As each foot of column of water exerts the same downward pressure per square inch as a column of mercury 0.8832 in. high, the downward pressure per square inch due to the 12-ft. column of water is the same as that due to a column of mercury,

$$12 \times 0.8832 = 10.6 \textit{ in.}$$

Therefore, when placed at *C* the gage would indicate

$$27 - 10.6 = 16.4 \textit{ in.}$$

vacuum.

In similar manner, with the difference of level of 15 ft. between the points *B* and *D*, there is a downward pressure at *D* due to the head of water from the level of *D* up to the level of *B*, which is equal to a column of mercury 15×0.8832 in. high. As this is equal to the downward pressure of a mercury column 13.25 in. high, the gage placed at *D* will indicate

$$27 - 13.25 = 13.75 \textit{ in.}$$

of vacuum.

Feasibility of Running Condensing

How much water at 55 deg. F. will be required for a jet condenser used with a 19x42-in. Corliss engine making 78 r.p.m.? The engine running noncondensing is so overloaded that frequently it will not cut off for three revolutions out of five for two hours at a time. What will be the temperature of the water discharged from a jet condenser? The condensing water would have to be raised about 50 ft. The only water supply available is now used for factory washing purposes, which could be continued provided the temperature was not excessive. Could the exhaust steam be carried through a closed heater before passing to the condenser? Some of the exhaust is now used for warming buildings with 3 lb. back pressure on the engine. Would it not be more economical to warm the buildings with live steam?

What would be the advantage of installing a jet condenser under the conditions stated, assuming that the water supply is sufficient? Of what advantage are two eccentrics on a Corliss engine?

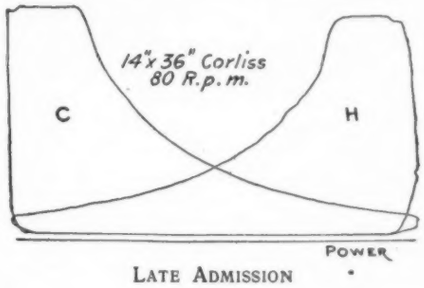
E. P. C.

About 25 times as much condensing water will be required as is needed for making the steam used by the engine. The temperature of condensing water leaving a jet condenser would be about 110 deg. F. The exhaust could be conveyed through a closed heater before going to the condenser.

The advantage of running an engine condensing will depend upon the cost of the water supply, the horsepower to be developed and the boiler pressure. The advantage of using live steam for warming purposes instead of exhaust with 3 lb. back pressure will depend upon the amount of steam required. If a large proportion of the exhaust can be used for heating and other purposes a condenser will not pay. A Corliss engine is operated with two eccentrics because an opportunity is thus afforded for adjusting the steam valves independently of the exhaust valves; an early release may be had without sacrificing compression, and the valve-gear will operate throughout a greater range of cutoff.

Late Admission

The late-admission diagrams herewith were taken with a 40-lb. spring from a 14x36-in. Corliss engine which makes 80 r.p.m. with 130 lb. boiler pressure.



LATE ADMISSION

What should be done to correct the late admission? The engine eccentric is keyed to the shaft.

E. P. F.

Adjust the length of the wristplate connections to the steam valves. It would be well, also, to close the exhaust valve on the crank end a little earlier by adjusting its connection so as to make the compression more like that of the head end, besides tending to equalize the size of the diagrams.

Determining Oil in Condensation

How can the amount of oil in return water from an exhaust-steam heating system be determined?

J. N.

A fair test of the amount of engine cylinder oil contained in a sample of condensation may be made by determining how much oil has to be added to a given quantity of fresh feed water, in order to cause the latter to present the same appearance of turbidity when equal quantities of each kind of water are mixed with the same quantity of any given solution of sodium hydrate (caustic soda). Care should be taken that all solutions are employed at the same temperature.

Study Questions

This Week's Questions
Last Week's Answers

11. A gasoline engine weighing 650 lb. is to be mounted on a concrete foundation 2 ft. high measuring on the top 2 ft. wide by 4 ft. long, and at the base 3 ft. wide by 5 ft. long. The sloping sides are flat and symmetrical; that is, the inclination is uniform, all sides making the same angle with the horizontal top. Required the total weight per square foot on the floor after the engine is in place, taking the weight per cubic foot of concrete as 125 lb.

12. A small power plant burned 56 tons of coal in the month of May. This was an increase over April of as much in per cent. as was burned in tons in April. What was the April consumption?

13. If a person is in a field of ice which moves west at the rate of two miles an hour, and he walks in a straight line at the rate of three miles per hour, in what general direction must he travel and how long will it take him to arrive five miles due north of his first position?

14. A ladder of uniform weight throughout, 30 ft. long, weighs 60 lb. and leans against a vertical wall, making an angle of 65 deg. 50 min. with the horizontal. A man weighing 150 lb. ascends 25 ft. on the ladder. Required the pressure against the wall.

15. The sum of the speeds of two pulleys is 110 r.p.m. One of the pulleys runs 100 r.p.m. faster than the other. What is the speed of each pulley?

Answers to the above will appear in the next issue. Answers to last week's questions follow:

6. Assuming an ordinary 110-volt direct-current circuit, the actual drop in voltage between the switchboard and the load would be

$$0.03 \times 110 = 3.3 \text{ volts}$$

From Ohm's law

$$R = \frac{E}{I} = \frac{3.3}{320}$$

Where

R = Resistance in ohms;
E = Difference in potential; in this case the drop in voltage;
I = Current in amperes.

The resistance of 1 ft. of copper, 1 circular mil in section, is 10.8 ohms. As the resistance varies directly with the length of the conductor and inversely as the cross-section, the resistance of 700 ft. would be

$$R = \frac{700 \times 10.8}{A}$$

where A is the area in circular mils. Substituting the value of R from the previous equation

$$\frac{3.3}{320} = \frac{700 \times 10.8}{A}$$

$$A = \frac{700 \times 10.8 \times 320}{3.3} = 732{,}000$$

circular mils

A 750,000-circular mil cable would be required.

7. The formula for a free fall in vacuo is

$$s = ct + \tfrac{1}{2} gt^2$$

where

s = Distance, or height in feet;
c = Initial velocity;
t = Time in seconds;
g = Acceleration due to gravity = 32.16 ft. per second.

Substituting the known values in this equation

$$493 = 50t + 16.08t^2$$

This is a quadratic equation solved by making the member involving the unknowns a perfect square by dividing through by the coefficient of t^2,

$$t^2 + \frac{50}{16.08} t = \frac{493}{16.08}$$

and completing the square by adding the square of half the coefficient of t,

$$t^2 + \frac{50}{16.08} t + \left(\frac{25}{16.08}\right)^2 = \frac{493}{16.08} + \left(\frac{25}{16.08}\right)^2$$

Extracting the square root of both sides

$$t + \frac{25}{16.08} = \sqrt{\frac{493}{16.08} + \left(\frac{25}{16.08}\right)^2}$$

$$t + 1.555 = \sqrt{33.577} = 5.794$$

$$t = 4.239 \text{ sec.}$$

8. One plant contained three full barrels, one half barrel and three empty barrels; the other two plants each contained two full barrels, three half barrels, and two empty barrels, making 3½ barrels of oil and seven barrels at each plant.

9. The valve is held down on its seat by the weight of the valve and valve stem (7 lb.) plus the downward pressure of the lever on the valve stem due to the weight of the lever

$$\left(\frac{42}{4} \times 14 = 147 \text{ lb.}\right)$$

plus the downward pressure of the lever on the valve stem due to the safety-valve ball or weight

$$\left(\frac{27}{4} \times 30 = 202.5 \text{ lb.}\right)$$

making a total of 356.5 lb.

The diameter of the valve being 3 in., it has an area of 7.0686 sq.in. exposed to pressure on the under side; therefore the valve will rise and blow off when there is a pressure on the under side of

$$356.5 \div 7.0686 = 50.43 \text{ lb.}$$

per square inch.

10. The discharge pressure 45 lb. per square inch is equivalent to

$$\frac{45}{0.433} = 103.92 \text{ ft.}$$

Subtracting this from the available head, 200 ft., leaves 96.08 ft. to overcome the friction in the pipe. The quantity of water discharged is 50,000 gal., or

$$\frac{50{,}000}{7.4805} = 6684.04 \text{ cu.ft.}$$

This being discharged in 10 hours,

$$\frac{6684\ 04}{10 \times 60 \times 60} = 0.1857 \text{ cu.ft.}$$

is discharged per second. The velocity through the pipe will be this last quantity divided by the area of the pipe, as yet unknown, but which may be expressed in terms of the diameter d in feet. Then

$$V = \frac{0.1857}{0.7854 d^2} = \frac{0.2364}{d^2}$$

Using Darcy's formula reduced to English measures, the friction head is

$$h = \left(0.0199 + \frac{0.00167}{d}\right) \times \frac{l}{d} \times \frac{V^2}{2g}$$

Substituting our known values,

$h = 96.08$ ft.;
$l = 5280$ ft.;
$2g$ = Twice the acceleration of gravity = 64.32;

$$V^2 = \left(\frac{0.2364}{d^2}\right)^2$$

$$96.08 = \left(0.0199 + \frac{0.00167}{d}\right) \times \frac{5280}{d} \times \frac{\left(\frac{0.2364}{d^2}\right)^2}{64.32}$$

which reduces to

$$6179.8656 d^5 - 5.8735 d - 0.4920 = 0$$

By inspection it will be seen that d must be a fraction; hence the pipe will be less than 1 ft. in diameter. By trial it will be found that the equation is satisfied by some value of d between 0.25 and 0.03 ft. or between 3 and 3.6 in. The nearest commercial size is 3½ in., which is therefore the size pipe to use.

Japan Gold Size for Joints

BY A. L. HAAS

A jointing material of considerable value, not generally known, is Japan gold size, which is a liquid used by painters for a drier.

In connection with pneumatic plants it can be used successfully and for compressor cylinder joints made with brown paper it has proved superior to the ordinary red lead and boiled-oil paint.

The material is sold by paint dealers everywhere and has good keeping qualities. Upon exposure to air it dries rapidly, forming a tenacious, adherent, transparent coating.

Unfortunately the writer has no data as to its behavior for joints having to withstand steam heat, but he sees no reason why it should not at least be tried.

Tricked the New Oiler

By E. M. Keys, Jr.

Dick, who was an old-timer with the oil can, was showing a young oiler the "ropes," who when he saw the automatic engine stop, promptly wanted to know what it was.

Dick told him that it was the "butterfly" and that it must always be kept cool; otherwise the engine would "go on the blink." After the boy had been oiling around for a while he thought he would feel the "butterfly." Of course, it was hot, and he lost no time in telling Dick that the thing was going to pieces.

Dick told him to hurry to the boiler room and get a sack of "vacuum" and be quick about it.

The oiler hurried up the stairs to the boiler room where Bill, the water tender, asked him what was the trouble. The kid said that No. 1 engine was burning up and he wanted a sack of vacuum, quick.

Bill went to a corner and dragged out a 100-lb. sack of portland cement and told the kid to make haste. Arriving at the engine room, Dick told the kid that he had the wrong sack as it was too coarse, and to take it back and bring a sack of fine vacuum.

The oiler struggled back to the boiler room, where he was again met by Bill, who asked what was wrong. The kid explained and another sack of portland cement was dragged out.

The kid picked it up and when half way down the stairs, puffing like a locomotive on an up-grade, and nearly all in, he was met by the chief, who wanted to know what he was in such a hurry about with that sack of cement. The kid explained, and the chief, with a snort, ordered the kid to take the cement back to the boiler room where it belonged and get busy with his oil can.

That Dick and Bill got a reprimand from the chief goes without saying, and while they enjoyed the joke they nevertheless took care to avoid the new oiler for several days.

A total storage capacity of 360,000 tons of coal is provided by the Lehigh Coal & Navigation Co. at its plant at Hauto, Penn. The plant is electrically operated throughout, and has four pivoted reloading machines, their combined capacity being 8000 tons per 10-hour day.

Reduction of Edison Rates in Brooklyn

The Brooklyn Edison Co. has just announced a reduction in its rates and a change in the system of charging which will become effective July 1, 1912. The present rate for retail lighting is 12c. per kilowatt-hour, and it is this class of consumers that is most affected by the change. At present there are three forms of contract, known as retail, intermediate and wholesale; there is also a special wholesale contract under which the guaranteed minimum is $3000 per year.

The new rates, however, are based on the maximum-demand plan. The highest rate will be 11c. per kilowatt-hour for the first two hours of average daily use of the maximum demand; for the third and fourth hours the rate will be 8c. per kilowatt-hour, and for all service in excess of four hours' average daily use of the maximum demand the rate will be 4c. per kilowatt-hour. The minimum bill will be $1 per month.

The maximum demand, except when otherwise requested by the customer, will be computed as a percentage of the connected load. For residences the maximum demand will be taken as 50 per cent. of the connected load, and for all other premises 70 per cent., each standard socket being rated at 50 watts. As an alternative, every customer has the privilege of using a demand meter to register the maximum demand, for which there will be an additional charge of $1 a month. Under the special wholesale contract the guaranteed yearly minimum will be reduced from $3000 to $2400, billed at $200 per month.

University of Wisconsin Extension Courses

A Wisconsin law will shortly make a youth's education compulsory up to the age of 16; then he may be apprenticed to a manufacturer who will agree to teach the boy the whole trade. The maximum working hours are 55 a week, five of which must be devoted to instruction in English, citizenship, business practice, physiology and such other subjects as are approved by the State Board of Industrial Education. The instruction may be given in a public school or in such other place and manner as may be approved by the board. Failure to attend will subject the apprentice to a loss of compensation for three hours for every one he is absent without cause.

In anticipation of this law, the University of Wisconsin has established courses in Milwaukee and several of the large manufacturing companies have promised to give some of their employees the necessary time off and allow them full pay.

In some cases the students come to the class rooms of the university and in others the instructor goes to the company shops where the students assemble in a room set apart for them. The subjects now being taught are shop mathematics, drawing, safety devices, English, citizenship, physiology and hygiene. These courses are only a small part of the university extension work which covers science, literature and the arts, as well as commercial, industrial and engineering work. Instruction is carried on by correspondence, class work and by a combination of both.

This year there are 67 class periods and about 1500 students, the bulk of the students being in the commercial, industrial or engineering courses, in charge of K. G. Smith, assistant professor of mechanical engineering.

Newark's Industrial Exposition

A very successful industrial exposition was held in Newark, N. J., in the First Regiment Armory under the direction of the local Board of Trade, from May 13 to 25. Among the exhibits were a number of engineering interest.

The Crane Co. displayed its full line of Cranetilt traps and valves for all purposes, and its rubber and composition sheet packing. The traps were shown doing actual service under and against compressed air, steam not being available. This company's new regulating valve was also exhibited. Adjoining the Crane booth was shown the Lambert Hoisting Engine Co.'s line of steam and electric hoisting engines and machinery. Further down the room the A. & F. Brown Co. displayed its line of pulleys, pinions, gears and bearings.

Directly across the aisle the Dixon Cascade Pump Co. drew much attention to its small centrifugal pumps, many of which were used by exhibitors for pumping purposes, among them, Ballantine Bros., brewers, who showed their product running from an inverted bottle suspended by a fine wire. The tube discharging the beer entered the neck of the bottle, and as the liquid ran out the tube was concealed, making it appear that the supply was inexhaustible.

The Eastwood Wire Manufacturing Co. displayed brass and bronze valves of all kinds. Nearby, the Watts-Campbell Co. had one of its 150-hp. Corliss engines belted and motor driven. Across the way were examples of the work of the Newark Central high-school pupils; a complete telephone central station of their own construction excited widespread interest.

Among other electrical exhibitors the General Electric Co. showed a full line of electrically heated chafing dishes, smoothing irons, radiators, disk stoves, glue pots, coffee percolators, toasters, cigar lighters, etc. The application of motor drive for devices used in hotels, restaurants, etc., included everything from an ice-cream freezer to a dough mixer. There were many fans and ozonators, and the lamp display was interesting in that the current consumed by the old Edison carbon and the new Edison Mazda lamps was metered as they burned side by side, showing the great economy of the Mazda. The General Electric Co. also displayed a color-matching outfit, consisting of an arc lamp fitted with a color screen which

removes the excess red, orange and violet, giving a spectrum which is closely like that of daylight.

The Westinghouse Co., in the next booth, showed its single, polyphase and prepayment watthour meters, a variety of alternating-current switchboard meters, power factor and frequency meters, and its 7-in. synchroscope; rectifier outfits for charging automobile batteries, lamps of all kinds, a number of small motors and a motor-driven eraser for use in the drafting room, were also shown.

The Crocker-Wheeler Co. had a large exhibit of its products, including a motor-generator set which supplied current to many booths; Remek lighting transformers, squirrel-cage induction and adjustable-speed motors, crane and rolling-mill motors and hoisting machinery.

The Bell Electric Motor Co. had an exhibit and demonstration of its single-phase motors equipped with a short-circuiting device which causes the machine to run as an induction motor after full speed is attained. The variety of goods shown by the Newark Electrical Supply Co. was very complete.

Ohio Society of Mechanical, Electrical and Steam Engineers

The above society responded to an urgent invitation to hold its spring meeting this year at Pittsburg, Penn., where, notwithstanding the limitations of its title, it has many members. The meeting, which was held on May 16 to 19, quite justified in interest and attendance this extra state excursion.

The first session was held at the rooms of the Engineers' Society of Western Pennsylvania, where, after an informal reception by the Pittsburg engineers, the visitors were welcomed to the city by Charles H. Garlick, the newly appointed chief boiler inspector of Allegheny County. Frederick W. Ballard, engineer of construction for the municipal electric-light plant of Cleveland, responded for the society. E. A. Uehling, of the Uehling Instrument Co., presented a paper upon the "Combustion of Coal in Relation to Boiler Economy"; and Ralph Beman, director of technical publicity for the National Electric Lamp Association, one upon "Modern Incandescent Lamps; Electrical, Photometric and Economic Characteristics." At another session, Francis Gangl, electrical engineer, Northern Ohio Traction & Light Co., read a paper on "Transformers and Transformer Connections Frequently Met in Practice."

Pittsburg offers generous opportunities for the entertainment of such a party and excellent use was made of them by the local committee under the chairmanship of William R. McCord, of the *Industrial World.*

On Thursday afternoon a visit was made to the Pittsburg testing station of the U. S. Bureau of Mines, where, among other interesting things, a convincing demonstration of the explosibility of coal dust was given upon a large scale.

After the adjournment of the evening session an "owl party" visited the Phipps power plant, where Chief Engineer John Hyde demonstrated his method of burning powdered coal in quite a different manner from that which had been seen in the afternoon at the Bureau of Mines. It is no reflection upon the powdered-coal demonstration nor upon Pittsburg to announce that the party adjourned to the Natatorium and took a midnight plunge in the swimming pool.

Following the Friday morning session, the visitors lunched with the students of the Carnegie Technical Schools, and visited the laboratories. The baseball game, which was scheduled as a part of the afternoon's program, being postponed on account of the weather, the company divided into parties and visited several of the local industries, including the Mesta Machine Co.; the Rankin plant of the McClintic-Marshall Construction Co.; the Jones & Laughlin Steel Co., and the Westinghouse Machine Co. The University of Pittsburg and the handsome power plant of the Carnegie Institute attracted many visitors.

On Friday evening, after a complimentary dinner at the Hotel Schenley, the visitors were taken to the theater. On Saturday there were further visits to industrial plants and other points of interest and the baseball game, without which a Pittsburg entertainment would be as naught, in the afternoon.

For the ladies, of whom an unusually large number attended, there were provided trips to the Allegheny Observatory, the Carnegie Institute Museum and Art Galleries, the Margaret Morrison Carnegie School for Women, the H. J. Heinz Co.'s plant, the Penns ··ania College for Women, etc., as well as automobile rides about the parks and city.

The fall meeting must be held in Ohio and in November. The selection of the city was left in the hands of the council.

National Gas Engine Show

The National Gas-engine Show, which will be held in Milwaukee, Wis., on June 17 to 22, under the auspices of the National Gas Engine Association, promises to be an exhibition which for the first time will be entirely devoted to the gas engine.

At the entrance to the Auditorium will be the exhibits of three large tractor companies, with the engines in operation. Gas and gasoline engines of various types for farm, marine, electric-lighting purposes will also be displayed, as well as dry batteries, magnetos, lubricators, clutch pulleys, spark plugs, etc.

At this exhibit the visitors will see as nearly as possible the actual operation of the engines and accessories as in ordinary service and run on their usual fuel.

During the show the National Gas Engine Association will hold its semi-annual convention; the meetings will be open to visitors.

Applications for space and further information should be addressed to O. C. Parker, president, National Gas Engine Association, La Crosse, Wis.

SOCIETY NOTES

The summer meeting of the American Society of Heating and Ventilating Engineers will be held in Detroit, Mich., on July 11 and 12, the details of which will be announced in an early issue.

The monthly meeting of the American Society of Engineer Draftsmen, held on May 16 in the Engineering Societies Building, was marked by the admission to junior membership of Miss Marie Oberlander, a student of architectural drawing at Teachers College, Columbia University. Miss Oberlander is the first woman to be elected a member of the society. The guest of the evening, F. F. Hickel, M. E., consulting engineer of Henry R. Worthington, delivered an interesting and instructive lecture on "Practical Applications of the Slide Rule." A paper by R. E. Boehck, a member of the society, of Evansville, Ind., on "The Development of Logging Machinery" was read and discussed.

PERSONAL

S. G. Pollard has resigned his position as mechanical engineer of the Cincinnati Water Works.

J. B. Merriam, of the Bruce-Macbeth Engine Co., Cleveland, Ohio, recently lectured on gas-engine construction and operation before the Sheffield Scientific School of Yale University. Various details of construction and plants in operation were illustrated by lantern slides.

E. J. Clarke has been appointed superintendent of the inspection department of the Casualty Co. of America, New York City, succeeding E. R. McAlenan. Mr. Clarke was formerly chief inspector of the Pennsylvania Casualty Co. and with the Hartford Steam Boiler Inspection & Insurance Co.

Orrin C. Lawrence has been appointed superintendent of the steam-boiler and flywheel department of the Globe Indemnity Co., New York. Mr. Lawrence has for several years been with the Hartford Steam Boiler Inspection & Insurance Co. and is regarded as one of the best posted men in the boiler business. He will assume his new position about June 1.

Moments with the Ad. Editor

Just recently, one of our advertisers received an inquiry from far-off India.

The inquiry came from an engineer in a little town called Ajmere, up in the mountains, in the province of Rajputana.

This engineer was "stuck" on a vacuum problem.

He needed assistance, and probably he was bewildered for a while as to how he was going to get it, in the interior of that undeveloped country.

But—this engineer was a reader of Power and in this instance, we mean, too, that he read Power advertising.

He saw an ad. that was suggestive. It was that of a well known manufacturer of traps and steam specialties.

So he sat down and wrote to this advertiser to the end of finding a solution to his problem.

His letter was brief and stated its purpose frankly.

Our advertiser gave this letter as much attention as if it had meant a big order.

They very graciously turned the matter over to their engineer, a well known trap expert.

As a result, the other-side-of-the-world engineer got some valuable information, and a correct solution of his problem, *gratis*.

That advertiser knew that he hadn't a chance on earth to sell the man in India.

But it didn't deter him from going to considerable trouble and expense to help the man out who had answered his ad.

It is the modern idea in business—to *serve*.

"Bread cast upon the waters" is no idle jest.

Another man, chief engineer of a large chemical plant, writes us as follows:

"In my experience of the past three years I have been directly responsible for the purchase, installation and successful operation of several thousand dollars' worth of Power Plant equipment advertised in the columns of Power. They have ranged from 1500 H.P. feedwater heaters, to steam and gas engine indicators with full equipment, valves from the 6″ non-return type for boiler stop valves, to 6″ multiple strainer type for condenser protection, float valves for the automatic control of tank water, reducing valves for the protection of copper and lead coils, regulating valves for the protection of copper and lead coils, regulating valves for both boiler feed, liquor feed, and vacuum pump regulation; in fact, valves of all kinds necessary in a plant where the process requires equipment for the generation and control of steam, electricity, vacuum for evaporation and condensation, and also for the handling of liquors, also compressed air for pumping purposes and the operation of pneumatic tools, steam pumps, steam traps and separators, and other apparatus and machinery the recommendation of which has been based on Power ads, and it may please you to know that I have yet to find the one that has not made good and been as represented."

There is eloquent testimony to the value of Power advertising!

"They have all made good." What does it mean? First, that the engineer has recommended and bought apparatus that *backed him up*. Second, that he has been able to show savings and results that mark him as the right man in the right place.

Some men are asleep at the switch. There's a dead one in every camp.

But wise engineers know from experience that there's much information to be gotten from the advertising pages that is not found in the reading pages. They know, too, from experience that when some new machine, or apparatus, or product makes its advent into the power field it usually comes heralded first through an ad in Power.

And, thanks be, the modern engineer is not a skeptic. He is not a captive of his prejudices. The day and time of that engineer has passed.

The engineer, today, when he sees something new that may mean the development of just so much efficiency, at the expenditure of merely his effort of investigation—the engineer of today *investigates*.

Look more to the advertising pages, readers. You'll find the advertiser's message to you interesting, concise, specific, and helpful.

There may be some new apparatus or appliance described in this very issue that will be new to you.

And perhaps—perhaps it may be something you actually need in your own plant.

NEW EQUIPMENT

ATLANTIC COAST STATES

Eastondale, Mass., contemplates the installation of a water-works system.

North Andover, Mass., contemplates the installation of an electric-light system.

Frank H. Winchell is interested in the construction of an electric-light plant at North Brookfield, Mass., to supply electricity to North Brookfield and vicinity.

The electric-light plant of the Boothbay Harbor Electric Light & Power Co., Boothbay, Maine, was recently destroyed by fire. The estimated loss is $20,000.

The School Department, of Providence, R. I., contemplates changes in the heating systems in five schools. Furnaces will be replaced by boilers.

The construction of a new substation at Pleasant View Beach, Westerly, R. I., is contemplated by the Westerly & Connecticut Ry. Co. R. W. Perkins, Norwich, Conn., is general manager.

The Binghamton Ry. Co. will expend about $75,000 for improvements and new equipment for its power plant on State St., Binghamton, N. Y. J. P. E. Clark is general manager.

E. I. Williams, treasurer of Cornell University, Ithaca, N. Y., will receive bids until 2 p.m., June 3, for the installation of a central heating plant at the New York State College of Agriculture.

Plans have been prepared for the construction of a water system to be installed at Seneca Falls, N. Y., by the Seneca Falls Water Co.

Stone & Son, Utica, N. Y., have prepared plans for the construction of a water-works system to be installed by the Brockport Holly Water Co., Brockport, N. Y.

Bids will be received about June 1, for the construction of a pumping station in connection with the water system at South Orange, N. J. John J. Boyd is engineer in charge.

The Normandy Heights Water Co. contemplates extensive improvements to the water system at Whippany, N. J.

The plant of the Glen Willow Ice Co., Main St., Manayunk, Philadelphia, Penn., which was recently destroyed by fire, will be rebuilt at a cost of about $100,000. Plans have been prepared by David Haire, Land Title Bldg., Philadelphia. P. P. Lubert is president and general manager.

Chester & Fleming, Pittsburgh, Penn., have been retained to take charge of the construction of a filtration plant at Phoenixville, Penn.

The Large Distilling Co., Pittsburgh, Penn., is receiving bids for the installation of an engine and a 75-kw. generator in its establishment.

The Uniontown Water Co., Uniontown, Penn., contemplates extensive improvements to its water-works plant.

Plans are being prepared for the improvement of the water-works system at West Philadelphia, Penn. Estimated cost, $300,000.

The construction of a new power plant in connection with the John Hopkins University, Baltimore, Md., is under consideration. Plans are being prepared by C. L. Reeder, Equitable Bldg., Baltimore. Ira Remsen is president of the university.

Plans are being prepared by G. E. Painter, 324 North Charles St., Baltimore, Md., for the construction of a cold-storage plant for the Peninsula Storage Co., at Pokomoke City, Md.

SOUTHERN STATES

Bids will be received by James Knox Taylor, supervising architect, treasury department, Washington, D. C., until June 21, for the installation of a central heating plant in the post office at Charleston, W. Va.

The citizens of Huntington, W. Va., have voted to issue bonds to the amount of $800,000 for the installation of a new water-works system.

Barnwell, S. C., has voted a bond issue of $22,000 for the construction of a water-works system and an electric-light plant.

Plans are being prepared by J. N. Johnston, Florence, S. C., for the construction of a water-works system at St. George, S. C.

Plans have been prepared by the J. B. McCrary Co., Empire Bldg., Atlanta, Ga., for the installation of a water-works system at Stevenson, Ala. Estimated cost, $14,500.

Hartsells, Ala., contemplates the installation of a water-works system and an electric-light plant.

Plans have been prepared for the installation of a water-works system at Paulina, La. Estimated cost, $8000.

The citizens will soon vote on the proposition to construct an electric-light plant at Decherd, Tenn. B. C. McGill is mayor.

G. W. Wendling is chairman of a committee appointed to investigate the feasibility of installing a water-works system at Coal Creek, Tenn.

T. V. Vigus, Memphis, Tenn., contemplates the nstallation of a refrigerating plant at its meat-packing plant.

Booth & Son will install refrigerating machinery in the building which they recently purchased at Pulaski, Tenn. An expenditure of $20,000 will be made.

The Moss Milling Co. has been granted a franchise to construct and operate an electric-light plant at Greensburg, Ky.

The construction of a new power substation at Hendersonville, Ky., is contemplated by the Nashville-Gallatin Interurban Ry. Co. H. H. Mayberry is general manager.

The installation of a 500-hp. boiler equipped with underfeed stokers in the Hospital for Insane, Hopkinsville, Ky., is under consideration.

Lancaster, Ky., will make extensive improvements to its water-works system. Bonds for the purpose have been sold.

The Board of Public Works, Madisonville, Ky., will purchase equipment for the proposed water-works system. Estimated cost, $25,000. J. F. Dempsey is a member of the board.

The Marion Electric Light & Ice Co., Marion, Ky., contemplates the enlargement of its plant.

The Eberman Water-Works contemplates the construction of an electric-light plant in connection with its system at Morgantown, Ky.

CENTRAL STATES

The construction of an ice plant at Ada, Ohio, is contemplated. Estimated cost, $50,000.

The power plant of the Saltillo Coal Co., Zanesville, Ohio, was destroyed by fire on May 17. The estimated loss is $15,000.

Plans have been prepared for the construction of an electric-light plant at Coatesville, Ind.

Plans are being prepared for the construction of a boiler house for the Michigan Cold Storage Co., Saginaw, Mich. Estimated cost, $18,000.

Onsted, Mich., contemplates the construction of an electric-light plant.

The Ann Arbor Abbattoir Co., Ann Arbor, Mich., will construct a new abbattoir. Plans are being prepared by E. Slochtemyer, Lincoln Inn Court Bldg., Cincinnati, Ohio.

Bids will be received by the city commissioners of Appleton, Wis., until June 5, for furnishing equipment for a pumping station. C. H. Vinal is engineer.

A. Thompson and associates contemplate the construction of an electric-light plant at Hills, Minn.

Marna, Minn., is considering the installation of an electric-light plant.

The citizens of Morris, Minn., are considering the construction of an electric-light plant.

WEST OF THE MISSISSIPPI

The Keokuk Gas & Electric Co. contemplates the construction of a new substation at Keokuk, Iowa. Estimated cost, $100,000. N. Bowlby is chief engineer.

Kimballton, Iowa, is receiving bids for the construction of a water-works system. Plans have been prepared by C. D. Forsbeck, Black Hawk Bank Bldg., Kimballton.

The construction of an electric-light plant at Little Rock, Iowa, is contemplated by H. A. Hatch.

T. W. Michel has been granted a franchise to construct and operate an electric-light plant at Orange City, Iowa.

The village board of Louisville, Neb., will receive bids until June 3, for the construction of a water-works system. Estimated cost, $16,000. C. A. Richey is chairman of the board.

Thomas Venning has been granted a franchise for a period of 30 years to construct and operate an electric-light plant at Harrold, S. D.

The plant of the Nevada Water Co., Nevada, Mo., has been purchased by the Missouri Pacific Ry. Co. and improvements are contemplated. E. F. Mitchell, St. Louis, is chief engineer.

H. M. Sharp and associates contemplate the construction of an electric-light and power plant at Mena, Ark.

Plans are being prepared by R. C. Huston, Exchange Bldg., Memphis, Tenn., for the construction of a water-works system at Wynne, Ark.

E. S. Smith contemplates the construction of an electric-light and ice plant at Brazoria, Tex.

The construction of a power substation at Lewiston, Idaho, is under consideration by the Lewiston-Clarkston Improvement Co. Estimated cost, $20,000. J. J. Jennings is superintendent.

Ridgefield, Wash., is considering the construction of a municipal water-works system. J. W. Blackburn is town clerk.

C. B. Morganthaller has been granted a franchise to construct and operate an electric-light plant at Lindsay, Calif.

BUSINESS ITEM

The Lunkenheimer Co., Cincinnati, Ohio, is distributing its 1912 catalog and will send a copy to anyone interested free of charge. It's a 654-page catalog and describes a large number of new goods. In addition to showing the large line of Lunkenheimer high-grade engineering specialties the catalog contains a large quantity of useful information of great value to engineers. Write to the company if you want a copy.

NEW CATALOGS

American Engine Co., Bound Brook, N. J. Booklet. "A Story Boiled Down." Illustrated, 19 pages, 3½x6 in.

Furnace Gas Consumer Co., Matteawan, N. Y. Pamphlet. Smoke consumer. Illustrated, 12 pages, 6¼x9¼ in.

Simonds Heating & Specialty Co., Grand Rapids, Mich. Catalog. Heating specialties. Illustrated, 64 pages, 6x9 in.

Staples & Pfeiffer, 102 Stewart St., San Francisco, Calif. Catalog No. 12, Oil burners. Illustrated, 62 pages, 6x9¼ in.

J. E. Lonergan Co., 211 Race St., Philadelphia, Penn. Catalog No. 150. Boiler, steam and gas engine fittings. Illustrated, 64 pages, 6x9 in.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

ENGINEERS to sell oils and greases in spare time. Box 662, Power.

DRAFTSMAN in New York City familiar with centrifugal pump designing, to do work in his own time. Box 663, Power.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AN EXPERIENCED draftsman and designer on turbine work; give references and full particulars of experience to "Engineer," 667 Power.

FACTORY SUPERINTENDENT or production man, to have entire charge of plant manufacturing high-grade steam and gas engines. Box 666, Power.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

AGENTS WANTED to sell forced draft blowers and damper regulators; will give exclusive territory to right parties; commission on sales. Turbo-Blower Co., 30 Church St., New York.

AGENTS selling to steam plants can make big money selling for us; no samples; no experience is necessary. Armstrong Mfg. Co., Springfield, Ohio.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators, traps and exhaust pipe heads; not necessary to represent entire line if interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

REPRESENTATIVES WANTED—Traveling representatives selling supplies to ice manufacturers and others engaged in the refrigerating industry, and who have spare time for an agreeable side line, can make an advantageous arrangement by addressing A. Smit, Room 1004, 116 Nassau St., New York.

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MECHANICAL ENGINEER, graduate, German, 26, seven years' practical experience, four years in United States, wishes position. Box 661, Power.

MECHANICAL and electrical engineer, technical graduate, 32, desires operating position; experience in designing and erecting machinery for engine building company, and as testing engineer for group of power plants. Box 652, Power.

GAS ENGINEER, now in charge of 350 kw. suction producer gas plant, desires a change; married, sober, and have good references; have had experience on single and double acting engines, suction and pressure producers, thoroughly understand electrical end; ten years' experience; will go anywhere. Box 664, Power.

MISCELLANEOUS

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WANTED—To buy electric light plant in a good city of about fifteen hundred to three thousand people, west of the Mississippi. Address W. M. Donner, Rossfork, Idaho.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

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ONE 500-horsepower Hoppes live steam purifier; one 35 kilowatt General Electric, 230 volt steam turbine and dynamo and switchboard panel; one complete Emerson steam pump, including working barrel, capacity 200 gallons per minute; two Worthington water meters; one iron tank, 60,000 tensile strength, 42" diam. and 9' high; two Bundy traps No. 100 and No. 52 series; two Anderson traps No. 3 and No. 2. All in A-1 condition; will sell cheap. Box 656, Power.

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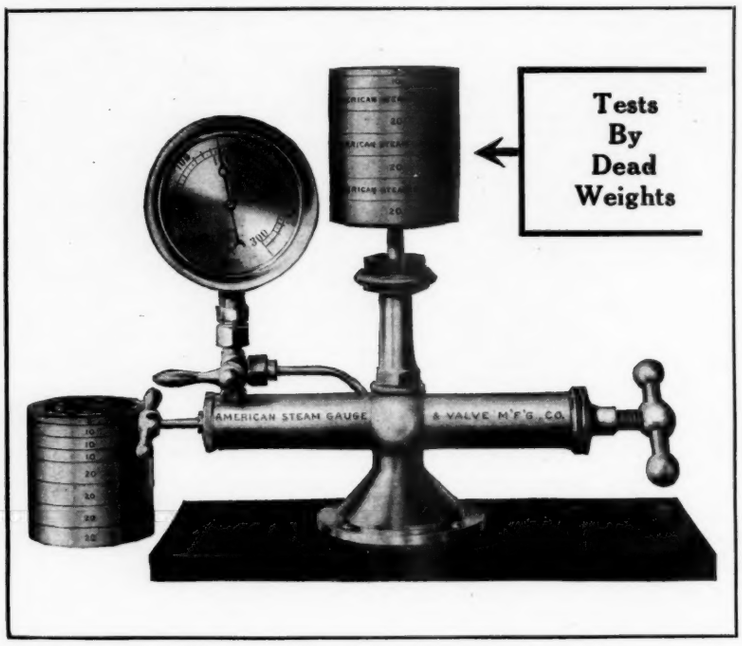

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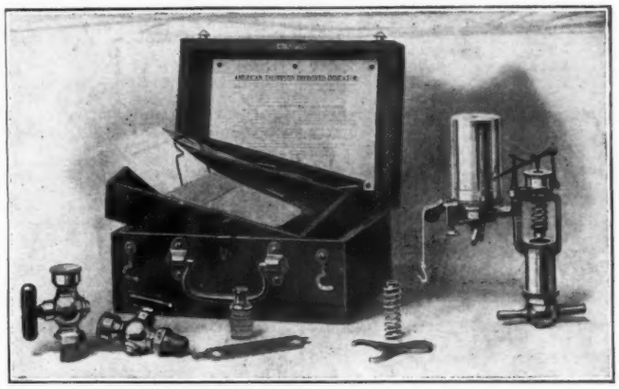

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WHAT AILS THE BOILER?

Boilers suffer from a variety of disorders, but at least 50% of them, the boiler inspection and insurance companies tell us, are due to cold, impure, scale-forming or corrosive boiler feed water.

All such **troubles can be cured easily and inexpensively by the installation of a Cochrane Open Feed Water Heater** to heat the water and drive off corrosive gases and air where the water contains "temporary hardness" only, **or a Sorge-Cochrane Hot Process Water Softening System,** which is like the Cochrane Open Feed Water Heater, only with functions extended to include the automatic feeding of a suitable reagent for correcting "permanent hardness," which causes hard scale and is not cured by heat alone, and proper facilities for settling and filtering out the sludge resulting from the treatment.

According to the nature of the water, one or the other of these appliances will give complete freedom from scale, corrosion and temperature strains, saving at the same time from 10 to 15% of the coal bill due to the better transmission of heat through clean plates, and the utilization of the exhaust steam to heat the boiler feed water.

FILL OUT THE FOLLOWING BLANK, showing what the symptoms are, and we shall be pleased to advise you regarding the treatment, and at the same time to send you our 50-page booklet *"What Scale Does to Boilers,"* and our 150-page book *"Cochrane Heaters and Their Use in Steam Power Plants for Heating and Purifying Water for Boiler Feeding and other Purposes."*

Harrison Safety Boiler Works
17th & Clearfield Sts., Philadelphia, Pa.

CUT OFF ALONG THIS LINE

HARRISON SAFETY BOILER WORKS PHILA., PA.

Kindly send me your book *"What Scale Does To Boilers"* and *"Cochrane Heaters and Their Uses."* The plant with which I am connected contains ..... boilers of .....H.P. each. The feed water is at present heated by..... and goes into the boiler at ....° F. We are (are not) troubled by (scale) (corrosion) in the boilers. We have exhaust steam, which could be utilized for heating the water, available from .....
We can also use exhaust steam for (low pressure turbines) (heating) (drying).....

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